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The Effectiveness of a Suggested Bioinformatics-based Program in Developing Biodata Analysis Skills and the Awareness of Some Neoteric Bioethical Issues among Students of Faculty of Education

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Summary

Introduction:

Due to modern technical developments that have led to the emergence of large data in different fields, such as biology, it has become difficult to analyze this data using the absolute human mind. Accordingly, informatics techniques have to be integrated to analyze these large data and to find answers and reach practical solutions to the many questions which biology poses. As a result, many modern sciences, such as bioinformatics, have emerged to take part in this tremendous development and to solve many biological issues.

This tremendous development in biological sciences, bioinformatics, and their applications is accompanied by a great debate on some ethical issues and the extent to which societal traditions and ethical values are counted when applying and using such fields in everyday life.

It has become necessary to reconsider not only these issues but also their pros and cons, bioethical sides, and the inevitability of making bioethical decision concerning these societal issues. This can only be achieved through developing individuals' awareness of such issues.

Educational institutions are one of the most significant active channels in achieving societal goals through preparing educational programs that help achieve social and cultural needs in light of changes and developments affecting different fields of life. In the few past years, many universities all over the world tried out to implement bioinformatics in their curricula and find the social and

ethical implementations. In addition, they encouraged students of biology to merge computer skills since the very beginning of their university education.

In spite of these efforts of achieving harmonization between current knowledge and university education, there are still large gaps that need further study to fill them in. Thus, it is necessary for these institutions to contribute to: educating individuals about the emerging ethical issues, forming positive attitudes, and taking the ethical decision and appropriate solutions towards these issues.

Research problem:

The problem of the current research is that there is a deficiency of biology teacher preparation programs in implementing: bioinformatics, skills of analyzing and processing bio-data, aspects of bioethics, and the use of computer software in learning contemporary biological sciences.

The field of bioinformatics is considered one of the contemporary trends that could contribute to solving the current research problem. This requires proposing a program in bioinformatics and measuring its impact on developing bio-data analysis skills and awareness of bioethical issues developed by students of the biology at the Faculty of Education through teaching the program.

The present research tries to answer the following main question:

What is the effectiveness of a proposed program in bioinformatics on developing skills of analyzing bio-data and awareness of the emerging bioethical issues among students of the Faculty of Education?

This main question poses the following sub-questions.

1. What are the dimensions of bioinformatics?
2. What are the skills of bio-data analysis that can be developed among biology students in the Faculty of Education through teaching bioinformatics?
3. What are the emerging bioethical issues that should be followed to develop awareness of biology students in the Faculty of Education through teaching bioinformatics?
4. What is the proposed vision for a bioinformatics program that could develop bio-data analysis skills and awareness of the emerging bioethical issues among biology students at the Faculty of Education?
5. What is the effectiveness of a bioinformatics program on developing bio-data analysis skills of biology students at the Faculty of Education?
6. What is the effectiveness of a bioinformatics program on developing awareness of the emerging bioethical issues of biology students at the Faculty of Education?

Purpose of the study:

The present study aims at:

1. Developing some bio-data analysis skills for third year students of the Faculty of Education - Biology major- through teaching the proposed bioinformatics program.
2. Developing awareness of some bioethical issues among the third year students of the Faculty of Education - biology major - through teaching the bioinformatics program.

3. Determining the effectiveness of a bioinformatics program on developing bio-data analysis skills and awareness of new bioethical issues among students of the third year of the Faculty of Education - Biology major.

Significance of the study:

The present study could help:

1. **Faculties of Education**: in terms of reviewing the preparation programs and emphasizing:
   - Integrating modern sciences programs, in particular bioinformatics.
   - Teaching different skills, in particular, skills of data analysis and inclusion of bioethical issues within their programs for developing bioethics.
2. **Student teachers**: in terms of emphasizing the development of bio-data analysis skills and their awareness of the emerging bioethical issues, emphasizing them in practical education programs, and how to develop the awareness of them among students.
3. **The Ministry of Education**: by doing a national project aiming at integrating modern sciences, in general and bioinformatics in particular, into its curricula and emphasizing acquiring various skills through it, especially skills of analyzing bio-data and developing awareness of emerging bioethical issues.

4. **Curricula planners**: in the inclusion of bioinformatics, and emerging bioethical issues within the curricula of the different educational stages.
5. **Curricula designers**: in designing educational programs, materials and activities of bioinformatics so that students could acquire bioethics through their awareness of emerging bioethical issues and bio-data analysis skills.
6. **Curricula evaluators**: in applying evaluation methods compatible with the objectives of bioinformatics education.
7. **Faculty members**: in emphasizing the importance of awareness of bioinformatics, and how to develop awareness of emerging bioethical issues and skills of bio-data analysis. Numerous educational studies and researches (such as Zhan et al.,2019) highlighted the importance of developing professors' skills to teach bioinformatics, its applications, and fields.
8. **Presenting two objective tools**: the bio-data analysis test, and the awareness test for emerging bioethical issues from which a faculty member can benefit in building similar tests.

Limitations of the study:

The present study is limited to:

1. The proposed program was applied to third year students - Biology major - Faculty of Education - Fayoum University during the second semester of the 2019/2020 academic year for these justifications: One of the prerequisites to studying the proposed bioinformatics program is studying the general

biology course taught in the first year and studying the molecular biology and computer courses, taught in first semester of the third year.

2. Dimensions of bioinformatics (the biological dimension - the technical dimension - the computer dimension - the statistical dimension - the ethical dimension) suitable for students of the Department of Biology at the Faculty of Education.
3. The skills of analyzing bio-data, appropriate to the level of the third-year biology students, which were represented in five main skills (analysis of protein sequences - analysis of DNA strands - analysis of genetic sequences statistically - translation of bio-data - analysis of DNA sequences using databases and digital analysis tools).
4. The emerging bioethical issues represented in four main issues, namely (whole genome rapid sequencing - genetic modification - plant genetic modification - plant piracy) and with which the third-year students should be aware

Hypotheses:

The present study tests the following hypotheses:

1. There are statistical significant differences between the mean scores of the experimental group of students in the pre and post tests of the bio-data analysis test in favor of the post test.
2. There are statistically significant differences between the mean scores of the experimental group of students in the pre and post awareness test of bioethical issues in favor of the post test.

3. There is an associated proportional relation between the experimental group students' performance in the awareness test and their performance in the bio-data analysis test.

Methodology:

The present study adopts the descriptive method and the quasi-experimental design.

1. **Descriptive analytical approach** is applied by reviewing the literature and referring to previous studies that contribute to developing the theoretical framework of the study and building the proposed program.
2. **Quasi-experimental design** will be used through the one-group experimental design to test the proposed program of bioinformatics.

Tools:

The measuring tools consisted of:

1. Bio-data analysis skills test. (Prepared by the researcher)
2. The awareness of bioethical issues test including three aspects of awareness (cognitive - skill - emotional). (Prepared by the researcher).

Procedures:

This study was conducted following these procedures:

1. Reviewing the literature on educational research, previous studies related to preparing and designing programs in the field of bioinformatics, developing skills of analyzing bio-data as well as emerging bioethical issues, and how to develop awareness of them.
2. Preparing an initial list of bioinformatics dimensions appropriate for students of Biology Department of the

Faculty of Education, consulting a group of experts and referees to determine its suitability, and editing it in light of their opinions to reach a final conclusion.

3. Preparing an initial list of bio-data skills appropriate for students of the Biology Department of the faculty of Education, consulting a group of experts and referees to determine its suitability, and editing it in light of their opinions to reach the final conclusion.
4. Preparing an initial list of the most important emerging bioethical issues required for the third year students of biology at the Faculty of Education, consulting a group of experts and referees to determine its suitability, and editing it in light of their opinions to reach the final conclusion.
5. Designing the proposed program in bioinformatics to develop bio-data analysis skills and awareness of emerging bioethical issues.
6. Preparing educational materials for the proposed program, such as:
   - Student-teacher's book of the proposed program.
   - Handbook of activities and exercises.
   - Teacher's guide for the procedures of implementing the proposed program.
7. Building a test to measure students' skills development in bio-data analysis.

8. Building awareness test in its three aspects (cognitive - emotional - skillful) to measure the extent to which students' awareness of the emerging bioethical issues is developed.
9. Consulting a group of experts and referees to determine the suitability of educational materials and editing them in light of their opinions to reach a final conclusion.
10. Applying the proposed program, educational materials, and measurement tools exploratory on a sample of the fourth-year students of Biology major in the first semester to test their validity and reliability and decide the appropriate time for measuring the tools.
11. Selecting a sample of experimental group of third-year students, faculty of Education, Biology section, Fayoum University.
12. Applying the research tools preliminary to the research group, monitoring the results, and processing them statistically.
13. Applying the proposed program for bioinformatics to the experimental group.
14. Applying the research tools to the research group postliminary, monitoring the results, and processing them statistically.
15. Interpreting the results and providing recommendations and suggestions.

Results:

The study has reached these results:

- **First, with respect to bio-data analysis test:**

There is a statistical significant difference at (0.01) between averages of the experimental groups in the bio-data analysis pre and post tests as a whole in favor of the post test. There also is a statistical significant difference at (0.01) between averages of the experimental groups in the bio-data analysis pre and post-test (measuring each skill separately) in favor of the post test. This indicates the effectiveness of the proposed program in bioinformatics on developing the students' skills of analyzing bio-data.

- **Second: with respect to testing awareness of the emerging bioethical issues:**

There is a statistical significant difference at (0.01) between averages of the experimental groups in the awareness of bioethical issues pre and post tests in favor of the post test. There also is a statistical significant difference at (0.01) between averages of the experimental groups in the pre and post tests of awareness of bioethical issues dimensions (Cognitive - Sentimental - Behavior) in favor of the post test. This indicates the effectiveness of the proposed program in bioinformatics on developing the students' skills of analyzing bio-data. It also indicates the effectiveness of the proposed program in bioinformatics on developing the students' awareness of bioethical issues.

- **Third: with respect to the relationship between the two research variables:**

There is an associated proportional significant relation at level (0.01) in the awareness test between the experimental group

students' performance and their performance in the analysis of bio-data. This indicates that improving the skills of analyzing bio-data leads to an improvement in the level of awareness of the experimental group and vice versa.

- **Fourth: with respect to the effectiveness of the proposed program:**

The effectiveness of the proposed program in developing awareness of the emerging bioethical issues and skills of bio-data analysis among student-teachers, the research sample.

Recommendations:

The researcher recommends:

1. The necessity of implementing bioinformatics programs within the preparation programs of biology teachers, in particular, and within other scientific disciplines in the Faculties of Education, in general. This could contribute to developing their skills in data analysis and awareness of emerging ethical issues in order to keep up with contemporary global trends.
2. The necessity of introducing contemporary biological sciences to students of biology and applying biology programs integrated with information technology, mathematics, and statistics.
3. Integrating electronic resources in biological education to develop students' skills of using technology in the scientific specialization so that it could contribute to developing their skills of analyzing various bio-data.

4. The necessity of integrating ethical issues into undergraduate preparation programs to develop awareness of them.
5. Paying attention to developing computer laboratories in faculties of Education to meet the objectives of scientific education in order to achieve integration of contemporary biological sciences with computer science and educational technology.
6. Preparing training programs for in-service teachers to train them on using computer sciences, information technology, and bioinformatics resources and tools to serve science curricula at various educational stages.
7. Preparing training programs for in-service teachers to provide them with knowledge, develop their awareness of emerging ethical issues related to biology, and train them on appropriate methods of integrating and teaching them to students.
8. Establishing a bioinformatics training center - at Fayoum University - to serves many researchers of vital disciplines in practical faculties, such as medicine, pharmacy, science, engineering, and agriculture, to provide training courses that serve their research field. The center will include multi-discipline professors interested in the field of bioinformatics. This will save money and time wasted on practical experiments. The importance of using bioinformatics tools and programs is reflected in simulating reality showing

results that accurately serve these experiments according to their specialization.

Suggested research:

In light of the results reached, the researcher proposes conducting the following research and studies:

1. Designing an electronic course in bioinformatics based on virtual classes and measuring its impact on developing the skills of analyzing bio-data and awareness of emerging issues among students of the faculty of Education.
2. The ethical principles upon which students of the faculty of Education judge bioethical issues and their impact on understanding nature of science.
3. A proposed training program in bioinformatics for in-service science teachers.
4. Developing a biotechnology course for scientific majors at the faculty of Education in light of bioinformatics and its societal applications.
5. The effect of integrating bioinformatics into the scientific majors programs of the Faculty of Education during the four academic years on achieving scientific enlightenment and awareness of bioethical issues.