DEVELOPMENT AND VALIDATION OF A MODULE IN HIGH SCHOOL SCIENCE II (GENETICS)

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APPROVAL SHEET

In Partial fulfillment of the requirements for the degree, MASTER OF ARTS IN EDUCATION MAJOR IN ADMINISTRATION AND SUPERVISION, this thesis entitled "DEVELOPMENT AND VALIDATION OF A MODULE IN HIGH SCHOOL SCIENCE II (GENETICS)", was prepared and submitted by PEDRITO G. PADILLA, who having passed the Comprehensive examination with a rating HIGH PASSED hereby recommended for oral examination.

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PEDRITO G. PADILLA

March, 1992
Catbalogan, Samar

DEDICATION

To my loving wife, Wennie

and

to our kids

Mark

Marisse

and Shiela,

this humble work is

heartily dedicated.

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ABSTRACT

The study attempted to develop and validate a module in high school science II (Genetics) which could be used by science teachers handling second year students. The absolute computed value of t in the control group and the experimental group are 10.12 and 18.88 respectively, which are both greater than the tabular t value of 1.725 at 0.05 level of significance at 20 degrees of freedom; hence, the above cited null hypothesis is rejected. That means that there were improved performance of the students in both the control and experimental groups. In the light of the aforementioned findings, the researcher had formulated the following conclusions. The sophomore students of Samar National School showed varying degrees of difficulty in high school genetics, specifically on the Mendelian Principles of Heredity and their present-day interpretations. Students in both groups learned much from said topics in High School Genetics. The control group and the experimental group had the same level of entry competencies. There is a significant difference between the post-test mean scores in the control and experimental groups. Therefore, the modular approach of teaching is more effective than the traditional method as far as the above cited topics in High School Genetics are concerned. There is a significant difference between the pre-test and post-test mean scores in both the control group and the experimental group. The module is appropriate and interesting for the second year high school students in terms of reading ability level.

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Chapter 1

THE PROBLEM AND ITS BACKGROUND

Introduction

We live in a science-concious age.[1] One cannot miss a radio or television program advertize products claiming that each product is the latest results of scientific research. It is a fact that our top government officials, especially the president and legislators have scientific advisers. A sizable amount of our annual budget and that from foreign loans are chanelled to scientific research and development.[2]

Our government is embarking on an ambitious project. It is the hope that our country will join the exclusive group of the so called "Newly Industrializing Countries" (NIC). Mitra, in his pronouncements, said that the development of the country's science and technology capabilities are essential for the attainment of NIC status by the year 2000.[3]

The lead agencies involved directly in this project are the Department of Science and Technology (DOST) and

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[1]William T. Keeton, Elements of Biological Science.(New York: W.W. Norton & Co., 1983), p. 2.

[2]Speaker Ramon Mitra, Bulletin Today, August 8, 1991.

[3]Ibid.

the Department of Education, Culture and Sports (DECS).

The DECS, through its Secondary Education Development program (SEDP), is embarking on a multi-million dollar loan program whose main aim is to improve the quality of education in our country, a constitutional mandate.[4] One of its major areas of concern is science and technology.

The SEDP[5] covers curriculum development, staff development and physical facilities development.

To improve the quality of education, SEDP has been focussing on curriculum reforms, provision of quality textbooks/teacher manuals on a 1:1 basis, provision of science and work education equipment, staff development (short- and long-term), assistance to private secondary education, research studies on NCEE, barangay high schools, career guidance, etc.

To effect efficiency in the system the SEDP has been focussing on research studies on school location and distribution, financing schemes, teachers' salaries and benefits, etc., training of administrators, strengthening of sector management and evaluation system.

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[4]Sec. 1, Art. XIV 1987 Constitution.

[5]Primer on the Secondary Education Development Program circulated by the DECS-Region VIII.

To expand access to the sector, the SEDP has been undertaking/expanding the school building program, the service contracting scheme, and alternative delivery system.

To insure equity in the system, the SEDP has been undertaking/expanding the school building program for local high schools and the equipment provision and technical assistance for disadvantaged areas.

The New Secondary Education Curriculum is one of the components of the SEDP under its curriculum development area.

The significant features of the New Secondary Education Curriculum[6] includes the following:

1. The objects are generally oriented to the development of values such as nationalism.

2. The curriculum prescribes a set of competencies in every subject area to be mastered by the students.

3. The curriculum employs a uni-disciplinary treatment of content.

4. The main structure of the curriculum is cognitive-affective-manipulative based.

5. The subjects are going to be taught within a forty-minute time frame, except Science and Technology and

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[6]Ibid.

Technology and Home Economics (T.H.E.) which shall be taught in 60 minutes in the First to Fourth Years for the former and in the First year and Second Year for the latter and 80 minutes for the last two levels for T.H.E.

6. In addition to Communication Arts in Filipino, Araling Panlipunan, Edukasyon Pangkatawan, Kalusugan at Musika will also be taught in Filipino. Values Education will be taught in English and Filipino with local languages as auxilliary media of instruction. The rest of the subject areas will be taught in English.

7. The new curriculum provides for the development of critical thinking, creativity, innovativeness and communicative competence.

8. The new curriculum makes ample provisions for the application of theories learned in practicum.

Definitely the DECS is playing a vital role in the preparation of our citizenry for the next century in order for us to be called by then a member of the Newly Industrializing Countries (NIC) group.

This SEDP project of gargantuan budget is timely in the light of a congressional report by Angara and Padilla[7] that the country's current educational system is fast deteriorating if not nosediving.

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[7]The Philippine Star, July 25, 1991.

The Samar National School of Catbalogan, Samar is one of the Regional Learning Schools (RLS) for Science and Technology in our country. As an RLS, the School is expected to be equipped well so that it will be a medium for the realization of the objectives of the SEDP. However, based on the observation of the researcher, there is still a big room for the need of more instructional materials most especially in the areas of science and technology, in general, and high school science and technology II in particular. It is a common observation that class sizes in said school are very big.

During planting and harvesting seasons of the year there is a case of too much absenteeism for students help their parents in such activities. In the light of this observation, these absentees could easily catch up with the missed lessons if self-learning instructional materials like modules are available. Because of this situation, the researcher attempted to develop and validate an instructional material, a module in high school science and technology II on the topic of genetics. It is hoped that after the development and validation of this module, the students and teachers will find the teaching-learning process a more fruitful one. The researcher further hopes that concerned school authorities will find this humble work as one of the

avenues for the attainment of quality education especially in this part of the country.

Theoretical Framework

This study is anchored on the pragmatist's point of view of the pupil as a basic component of the educative process.

Based on the pragmatist's conception of the pupil, individuality is a consideration in the teaching-learning process. The doctrine of individual differences has gotten wide currency in educational thought today.[8]

The uniqueness of the individual is given an importance. Indeed, no two individuals are exactly alike. Even identical twins have tendencies to grow and develop according to the environment they are in. Thus, the saying "Gene proposes, environment disposes."

Butler further states that:

> Individualization is a significant characteristic and experience in general... There are individual things, individual events, individual relations, individual selves, and individual situations. So much are all of these individuals that there are no general rules that can be applied wholesale to them... they are concrete individuals who must be dealt with as unique.[9]

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[8]Donald Butler, Four Philosophies and Their Practice in Education and Religion. (New York: Harper and Row, Inc., 1968), p.409.

[9]Ibid.

The greatest challenge in education today is to provide the means whereby each young person can progress at his maximum rate as far as he is able to go.[10]

Each and every individual has his own strengths and limitations. Traditional formal education emphasized much on the content rather than the pupil's capabilities. Discussions of topics progress disregarding the pace by which the pupils can cope up with. As long as the teacher finishes his course content, he is already satisfied.

But the education of the child is not accomplished by the acceleration and retardation of grades because, according to Collete,[11] "students who are given this form of treatment are faced with many social adjustment problems."

Mass education techniques ordinarily used are unsuitable for students who should progress more rapidly, or more slowly, or in other direction.[12]

The philosophy behind the learning modules hinges on the generally accepted fact that each child is a unique

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[10]Zenaida M. Lacambra, "Development and Validation of Modules in Applied Science 101 Electrochemistry". (Unpublished Master's Thesis, MIST, Marikina, 1986), p.6.

[11]Alfred T. Collete, Science Teaching in Secondary Schools. (New York: Allyn and Brown, INC., 1973), p.519.

[12]Lacambra, loc. cit.

individual with background, experience, inborn qualities, habits, and learning styles different from those of other individuals, and as such he should be enabled to grow and develop to his optimum potential at his own pace.[13]

According to Torralba:[14] "The module as an instructional material possesses the qualities that will make an individual an independent learner, self-pacing or progressing at his own rate, of course, allowing measures to meet the needs of individual differences and contributing to a feeling of success no matter how humble it may be until finally, the feeling of self-satisfaction is attained."

Conceptual Framework

The study is focused on high school genetics, a lesson of the subject Science and Technology II of the New Secondary Education Curriculum (NSEC) under the SEDP.

The two major variables are the traditional approach of teaching and the modular approach of teaching (Figure 1).

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[13]Herminigilda R. Perez, "Development and Validation of Module on Progression in Math for Technology 201 for DIT students at SSPC." (Unpublished masters's thesis, MIST, Marikina, 1988), p. 23.

[14]Constantino M. Torralba, "Learning Modules as Instructional Materials." (Unpublished Master's Thesis, PLM, Manila, 1983), p. 25.

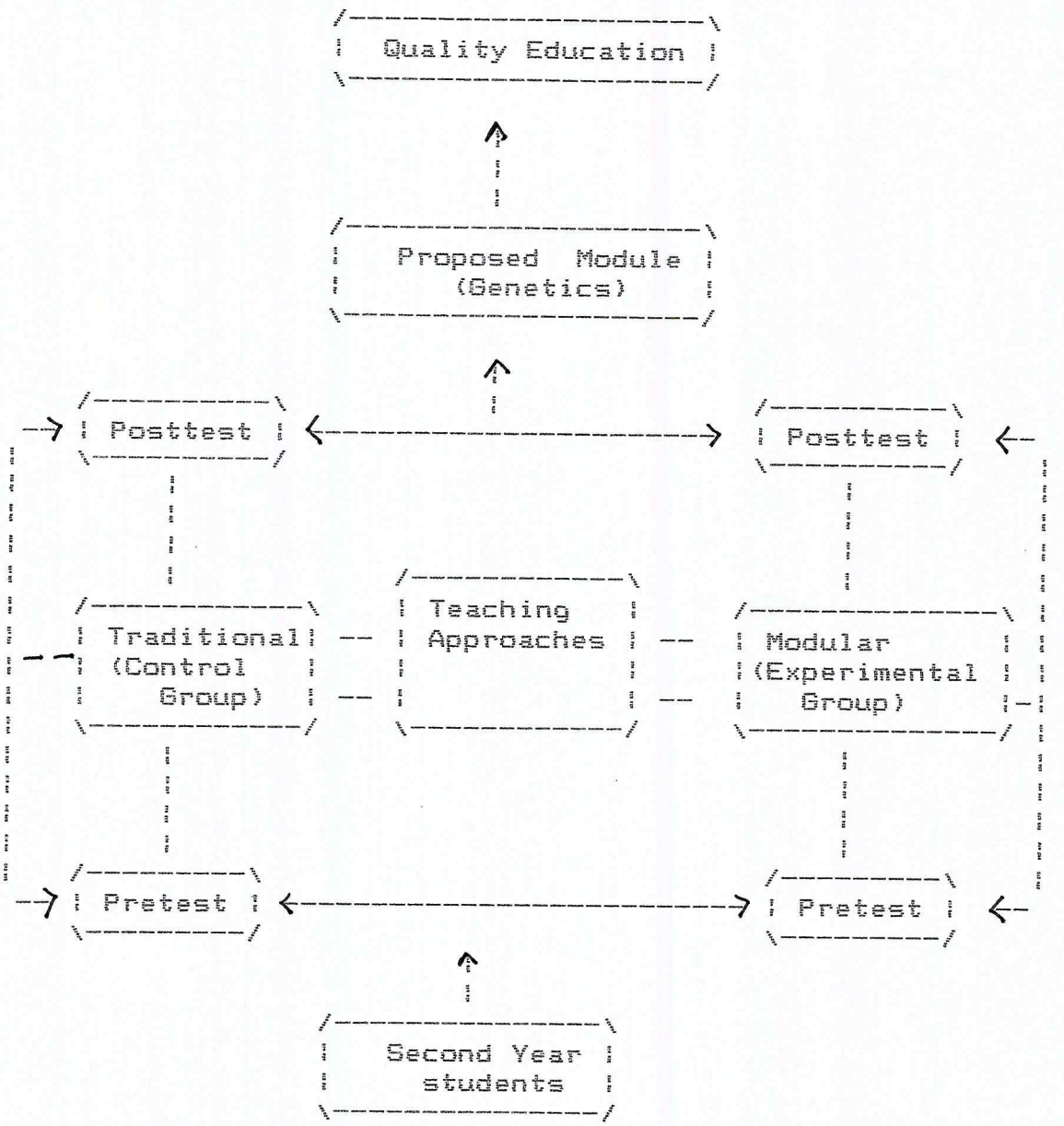

Figure 1. Schema showing the two major variables of the study: Traditional (Control) and Modular (Experimental) approaches of teaching towards the ultimate goal of quality education.

A 50-item validated teacher-made test was administered to the students in the class where the traditional approach of instruction is given as well as to those in the class in which the modular approach of teaching is employed. The corresponding posttests were undertaken after the throughput and comparisons of results were made between: (1) pretest in the control (traditional) and experimental (modular) groups; (2) posttest in both groups; and (3) pretest and posttest for each group.

The findings and their implication would serve as feedback mechanisms to the concerned administrators for instructional redirection in order to attain the ultimate goal of the study which is quality education.

Statement of the Problem

This study attempted to develop and validate a module in High School Science II (Genetics). Specifically, it sought to answer the following questions:

1. What are the socio-economic status, age and sex of the respondents in the

    1.1 Control group?

    1.2 Experimental group?

2. What topics in High School Science II (Genetics) can be modularized?

3. Is the readability level of the developed module appropriate to the second year high school students?

4. What are the mean scores of the control and the experimental groups in the

4.1 Pretest?

4.2 Posttest?

5. What is the mean gain in the

5.1 Control group?

5.2 Experimental group?

6. Is there a significant difference between the control and the experimental groups with respect to their mean scores in the

6.1 Pretest?

6.2 Posttest?

7. Is there a significant difference between the Pretest and the Posttest mean gains of the

7.1 Control group?

7.2 Experimental group?

Hypothesis

This study attempted to test the following hypotheses:

1. There is no significant difference between the control group and the experimental group with respect to their mean scores in the

1.1 Pretest

1.2 Posttest

2. There is no significant difference between the Pretest and the Posttest mean scores of the

2.1 Control group

2.2 Experimental group

Significance of the Study

This study was undertaken to develop and validate a module in High School Science II (Genetics) which students find difficulty to comprehend.

The development of a module in the above-mentioned area can partially alleviate the inadequacy of textbooks and reference materials in various schools today.

Aside from the students, the teachers and administration officials could also be benefited from this study.

Because of the limited budget of the DECS many schools have oversized classes; that is, more than the ideal teacher-student ratio of 1:40. Teachers complain of their ineffectivity of handling such big classes. With the development of modules, it could be possible to handle many students in one class.

It is more economical to mass produce modules in schools rather than depend on commercially available books which are more expensive, thereby, giving students more access to such kind of instructional materials.

The community as a whole will also be benefited because of the possible improvement on the students' performance.

Other reasons on the significance of this study include the following:

1. It tries to develop interest among the students on the subject of genetics.

2. It can serve as a basis for evaluating the genetics content of Science and Technology II in high schools.

3. The prepared module included in this study will improve the learning competencies of the students because it was devised within their own level of understanding.

4. This can serve also as a springboard for other subject areas.

Finally, with the use of modules more time can be alloted to actual teaching. It tries to minimize the "talking" sessions of the teachers. This will definitely improve the delivery of lessons, consequently, result a better quality of instruction.

Scope and Delimitation

This research study is limited to the development and validation of module in High School Science II (Genetics), specifically Lesson 18 of Unit 7 of the new textbook in Science and Technology II. This module was intended for the use of second year students of Samar National School,

Catbalogan, Samar. It covers about one- half of the lessons in the fourth grading period of the school year.

The topic on genetics was chosen by the researcher because of the feedback of SEDP trainees for Science and Technology II held in the summer of 1990.

Genetics is one of the most difficult topics in Science and Technology II.

The subject on genetics covers one unit of study based on the Desired Learning Competencies (DLC) prepared by the University of the Philippines Institute for Science and Mathematics Education Development (UPISMED) as adopted by the Bureau of Secondary Education (BSE) of the DECS under the Secondary Education Development Program (SEDP).

This study tried to identify the difficulties the students encountered in the study of genetics through the administration of a diagnostic test, a 50-item teacher-made test.

A table of specification was prepared for content validity.

The researcher made use of a 50-item teacher-made test for the pretest and posttest. These items were criterion based, that is, based from the objectives of the unit on genetics as contained in the DLC.

The module was evaluated for its effectiveness and readability level using the t-test for correlated and un-

correlated means and the Flesch formula.

Definition of Terms

The following terms are defined for a common point of reference.

Appropriateness. It refers to the reading ease score of the module and indicates to what year level it is suited for.

Control group. This is the group that is subjected to traditional instruction; it is the group with which the experimental group is compared.

Degree of freedom. Any of the unrestricted, independent random variables that constitute a statistic.[15]

Development of Module. This phrase refers to the making of a module.

Diagnostic test. It refers to the 50-item teacher-made test that is employed as an instrument to identify the difficulties of the students.

Evaluation. It refers to the assessment and reaction of selected groups to a set of criteria on how the module is prepared.

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[15] The Grolier International Dictionary (Connecticut: Grolier Inc., Vol. 1, 1986), p. 347.

Experimental group. It is the group which is subjected to modular instruction.

Flesch formula. It refers to the instrument used in determining the readability level of the developed module. It consists of the human interest score (HIS) and the reading ease score (RES).

Genetics. It is the branch of biology that deals with heredity and variation in similar, or related organism.

Mean gain. It is the difference between the mean scores in the pretest and posttest.

Modular instruction. This phrase refers to the type of instruction which makes use of modules as an instrumènt in the teaching-learning process.

Module. It is a self-contained and independent unit of instruction with a primary focus on well-defined objectives.

NSEC. It is an acronym for New Secondary Education Curriculum. It is a project under SEDP.

Posttest. It is the test given after the module has been taken up and it aims to evaluate the achievement of the students through the total application of skills and knowledge that have been sequenced for the module.

Pretest. It is the test administered before the module is given to the repondents to determine the extent

of knowledge they have on the lessons being modularized.

School. When it starts with a capital letter, it means the Samar National School of Catbalogan, Samar.

SEDP. It means Secondary Education Development Program.

Satistically significant. It means probably caused by something other than mere chance[16]

Technology. It is the science of the application of knowledge to practical purpose: applied science.[17]

Traditional method of Teaching. As used in this study, it means any teaching method without the use of modules.

Validation of module. It is the process of testing the effectiveness of the module.

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[16]Webster Third New International Dictionary (Chicago: Encyclopedia Britanica., Vol. III), p. 2348.

[17]Ibid., p. 2116.

Chapter 2

Review of Related Literature and Studies

This chapter presents the related literature and studies which helped the researcher develop and validate a module in High School Science II (Genetics) for the second year students of Samar National School, Catbalogan, Samar. The researcher referred to a number of published articles, books, magazines, and periodicals written by both Filipino and foreign authors and newspapers. Likewise, theses related to the researcher's study were referred to. These references helped to establish some basic facts and principles which were useful in the preparation of this study.

Related Literature

The Department of Education, Culture and Sports is now faced with the tremendous task of alleviating the sad fact that the quality of education in the Philippines is deteriorating. Quality education is the battlecry of this department.

In the name of quality education, great innovations cropped up and are still cropping up. The latest of which is the New Secondary Education Curriculum under the SEDP.

The objectives, structure and content of the New Curriculum are in compliance with the following consti-

tutional provisions.[18]

- Article XIV, Sec. 1, mandating the State to promote the right of all citizens to quality education at all levels and to take appropriate steps to make such education accessible to all.

- Sec. 2, the State shall:

(1) Establish, maintain, and support a complete, adequate, and integrated system of education relevant to the needs of the people and society;

(4) Encourage non-formal, informal, and indigenous learning system, as well as self-learning, independent, and out-of-school study program particularly those that respond to community needs.

The Education Act of 1992, which articulates the constitutional mandate on quality education, in a declaration of basic policy states that:[19]

(a) x x x "It is the policy of the State to establish and maintain a complete, adequate and integrated system of education relevant to the goals of national development."

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[18]Loc. Cit.

[19]As quoted in Readings on New Thrusts in Education edited by Jaime M. Gellor, et. al (Unnamed publisher, 1984), p. 33.

(b) x x x "The State shall promote the right of every individual to relevant quality education, regardless of sex, age, creed, socio-economic status, physical and mental conditions, racial or ethnic origin, political or other affiliation. The State shall therefore promote and maintain equality of access to education as well as the enjoyment of the benefits of education by all its citizens."

(c) x x x "The State recognizes that formal education of the school system, is society's primary learning system of the country's educational goals and objectives."

The SEDP is only one of the government projects which hopes to promote quality education in our country.

Another innovation which is now enjoying acceptance is the modular approach of teaching. This method of teaching takes into consideration the individual differences of students;[20] some are fast learners, others are average, and still others are slow learners. Certain forms of groupings, independent work, and individualized instruction can be used for both rapid and slow learners when facilities permit.[21]

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[20]Collete, Loc. cit.

[21]Ibid.

The modular approach enables the teacher to facilitate the learning process in an individualized manner because as cited in the preceding paragragh, there is grouping each for the fast and slow learners. More follow-ups are given to the slow learners and enrichment topics are given to the fast learners. This makes the teaching-learning process more on a personalized and individualized manner.

The unique nature of the modular approach is student-centered. The student is the focal point of education. Based on this premise, Fernandez[22] posed this question: What do we want our students to learn? This question was answered by herself with the following:

1. to help them, and lead them by presenting an example, to think clearly, logically, deeply, and widely about the human being <u>not</u> as a <u>what</u>, but more as a <u>who</u>, and his human condition specifically as a Filipino, and an Asian, and generally, as a member of the human race, and this planet Earth we call home.
2. to express themselves correctly, clearly, cogently, if possible, - eloquently through verbal

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[22]Bellor, et. al., loc. cit., p. 56-57.

oral language.

3. to enable them to discriminate between values, purposes, means and ends -not only to think statistically but critically.

4. to enable them to evaluate, and give meaning and significance to human experience in terms of not only intellectual, but emotional and moral dimensions.

5. to develop the capability to make moral choice, and arrive at ethical decisions no matter what the circumstances are/or how difficult they may be, especially in times of crises, and conflicts.

6. most importantly, to enable them to translate into contemporary terms, in situ, lessons of the past: the ability to intergrate facts, figures, views plus the ability to modify, qualify knowledge according to human experience in critical situation demanding ethical choices and decisions that can only be arrived at through an exercise of moral responsibility - the inevitable corollary to freedom.

It is within the context of individual differences that the great philosopher-psychologist John Dewey "drifted away from Hegel's idealism towards the pragmatism of William James. This meant that he came to reject that the

view of truth is fixed and unchanging in favor of the view that truth is determined on the basis of the consequences of the ideas.[23]

The philisophy of pragmatism is very much related to this study.

Pragmatism[24] was dominant in America during the first quarter of the 20th century, based on the principle that the usefulness, workability, and practicality of ideas, policies, and proposals are the criteria of their merit. It stresses the priority of action over doctrine, of experience over principles; and holds that ideas borrow their meanings from their consequences and their truths from their verification. Thus, the ideas are essentially instruments and plans of action.

It means, therefore, that education must be based on the principle that "the utility of things" be given more emphasis rather than its nature. Furthermore, education must dwell more on the part of the child, there must be freedom of activities.

The modular approach is supported by Dewey's philosophy which is reflected in his educational theory that

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[23]Encyclopedia Americana. (Connecticut: Grolier Inc., Vol. 9. 1984), p. 46.

[24]Encylopedia Britanica. (Chicago: Encyclopedia Britannica, Inc., Vol. III), p. 174.

emphasizes on the importance of "learning by doing" and its "opposition to stress on dogmatic and authoritarian teaching methods and on rote learning.[25]

According to Butler,[26] education must have the following objectives:

a. Give the learner experience in effective experiencing;

b. The school supplies the volume of learning to the needs of the new goal:

c. Correctedness in growth wherever growth may lead, there must be continuity in the means by which objectives are reached;

d. Preparation for the future;

e. Freedom of activities;

f. Better organized environing world; and

g. Social efficiency - effectiveness of individual in relation to society.

In effect education must revolve around the child's growth and development. In essence, education is child-centered.

Based on the foregoing statements, it is safe to say that instructional materials that are geared towards

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[25]Loc. cit.

[26]Butter, op. cit.

dealing with individual differences must be developed and validated. These materials must form part of the whole educational programs which are flexible enough to be suited to a wide range of individual differences. One of these is the so-called modules.

According to Creager and Murray,[27] modules are self-contained and independent units of instruction with primary focus on a few, well-defined objectives. The authors further add that the use of modules offers the following advantages not only to the students but also to the teacher:

1. Provides opportunity for organizing numerous sequences of experiences to reflect special interest of the instructor (teacher) to the student;

2. Allows the instructor to focus on the deficiences in the subject matter;

3. Serves to eliminate the necessity of covering subject matter already known to the students;

4. Assesses the progress of students in learning; and

5. Reduces routine aspect of instruction giving the

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[27]Jean Creager & Darrel L. Murray, The Use of Module in College Biology Teaching. (Washington D.C.: The Commission of Undergraduate Education and Biological Science, March, 1971). pp. 242 - 243.

teacher a chance to enjoy her personal contact with the students.

As gleaned from Creager's and Murray's ideas, modules are two-pronged in terms of benefits, i.e., for both the teacher and the learners. The teacher enables himself to have a more personal commitment to his wards. Conversely, the students can socialize more both to their teacher and themselves.

Topics which are already familiar to the students cannot be included in the teaching-learning process; hence, topics that need more attention and emphasis be given priorities.

Though the use of the modular approach of teaching is characterized by individualized instruction, it does not mean mere isolation but an instruction outside the formal educational apparatus, whether within or without the educational system.[28]

Educators today are faced with the great challenge of providing each student means by which he could progress in his educational pursuit in the midst of knowledge explosions and a fast-paced mode of living. The present

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[28]William V. Mayer, Considerations Regarding Individual Instruction. (Manila: Fourth Asian Regional Conference in Biology Education Aug. 1972), pp. 415-419.

environment of technological and scientific advancement along with increasing disparity between the rich and the poor situation whereby students have to cope up with in search of education. A consequential event would be the aggravation wherein some students could be very fast learners while others are not.

Because of the above- cited situation, there is an urgent need for educational projects which will meet various individual differences among learners.

Dowdeswell[29] presents convincing argument in favor of the modular approach in individualizing learning; to wit:

1. It enables a section of subject matter to be broken into small units, thereby easing its assimilation by the students.

2. In order to achieve understanding, most students need to repeat some sections of the work. The modules greatly emphasize and simplify such repetitions.

3. Since each module is a complete educational entity, close integration can be achieved between the different methods of presentation.

4. Since much of the work may require the students to be seated on a learning booth isolated from his imme-

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[29]W.H. Dowdeswell, "A Modular Approach in Biology Curricula." Fourth Asian Regional Conference in Biology Education, 4th ARCBE, August. 1972, p. 434.

diate neighbor and with few distractions, his level of concentration is likely to be increased.

5. The availability of such a wide range of methods for communication-audio-tape, slides, films, programmed texts, charts, diagrams, and living organisms means that each student has an opportunity to respond to those media in which he exhibits the greatest sensitivity.

6. The wide range of media available permits the method of communication to be closely related to the material being learned.

7. Modular approach enables the overall programme of a student to be much more closely and logically sequenced than is possible using traditional teaching approach.

Related Studies

The following are some of the related studies which show similarities to the current study.

The use of modules offers opportunities for organizing varied learning experiences that reflect the learner's interest. The learner is given choices to select the experiences that will satisfy his goals, eliminating the coverage of materials known to the learner.[30]

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[30]Lacambra, op. cit.

Lacambra,[31] in her study "Development and Validation of Modules in Applied Science 101 (Electrochemistry)" made use of the experimental method of research.

Lacambra's study found out that there was a significant difference between the mean scores in the pre-test and posttest of the control group. Other findings include: (1) there is no significant difference between the mean scores of the pretest of both the control and experimental groups; and (3) the style of the instructional material was interesting.

Based on the findings, Lacambra concluded among other things that (1) the modular approach is more effective than the lecture method in so far as the sub-topics oxidation-reduction and chemical effects of an electric current are concerned. The fact is that students can go through the modules at his own pace, repeat some sections of the work if needed, and progresses at his own rate until the feeling of self-satisfaction is attained; and (2) the modules are appropriate and interesting to the first year DIT students.

Lacambra recommended that:

1. Teachers/instructors should be encouraged to prepare other modules on other areas of chemistry.

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[31] Ibid., p. 48.

2. Teachers/instructors should be motivated to prepare other instructional materials aside from modules to alleviate the problem on the inadequacy of instructional materials in most schools.

3. The developed modules on electrochemistry, particularly oxidation-reduction and chemical effects of an electric current, should be used and evaluated in other schools to further confirm its effectiveness.

4. School principals/superintendents should give full financial support to their teachers/instructors in the development of any instructional materials for the school.

Perez,[32] in her "Development and Validation on Progression: A Topic in Mathematics for Technology 201 for DIT Students at Samar State Polytechnic College, Catbalogan, Samar", focused her study on the development and validation of instructional materials in the form of a module based on the identified difficulties in progression, a topic in mathematics for Technology 201.

Like Lacambra, Perez employed the experimental method of research. The latter also employed similar statistical tools.

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[32]Perez, op. cit. p. 51.

In her study, Perez found out that there is a significant difference between the pretest and posttest scores of the experimental group. Other findings include: (1) there is a significant difference between the posttest mean scores of the experimental and control groups; (2) module is appropriate to the respondents in terms of readability level.

Based on the readability level the material (module) was found out to be fairly difficult.

In the light of the above findings, Perez concluded that:

1. College students of the Samar State Polytechnic College have varying degrees of difficulty in progression, a topic in Mathematics for Technology 201.

2. There is a significant difference between the pretest and the posttest mean scores of the experimental group and control group in the same learning content.

3. There is a significant difference between the posttest mean scores of the experimental and control groups in favor of the modular instruction method.

4. The instructional material is appropriate for the second year college students in terms of readability level.

Based on the above conclusions, Perez recommended the following;

1. Students with identified difficulties should be given learning materials like modules to give them time to catch up with the lesson not well learned from the classroom.

2. Workshop on module preparation and construction should be conducted to provide basic knowledge to teachers with the end in view of producing modules in other related subjects which should be financed by the administration.

3. Students should be exposed to modular instruction to develop in them the feeling of independence and selfconfidence in learning a lesson without the teacher's aid.

4. Similar studies on other subjects should be done.

5. Teachers should be motivated and supported to undertake further researches on the effectiveness of modular instruction towards improving teaching-learning process.

Labro,[33] in his study found that there was a significant difference between the pretest and posttest scores of the experimental group. He also found out that there was

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[33]Jose S. Labro, "Development of Self-Instructional Materials that Meet Selected Deficiencies in Physics of Students in the BSIT Curriculum, SSPC". (Unpublished Master's Thesis, MIST, Marikina, 1986).

a significant difference between the means of the posttest scores of the two experimental groups.

Based on his findings, Labro concluded among other things that:

1. The developed materials are effective self-intructional materials as evidenced by the significant increase in test achievement of the engineering group which had no previous knowledge in fluid mechanics;

2. The developed materials are effective remedial resource materials in meeting deficiencies of students in fluid mechanics as evidenced by the significant increase in test achievements of the BSIT group;

3. The developed instructional materials exhibit the same effectiveness whether for self or remedial instruction purposes; and

4. The developed materials are appropriate for second year college students in terms of the level of readability.

Based on his conclusions, Labro recommended the following:

1. Teaching methodology employed in the existing Physics course in the BSIT curriculum of SSPC should be improved to remedy the difficulties in comprehension and application of the concepts encountered by the students;

2. Self-instructional materials should be developed

based on the remaining deficiencies revealed by this study;

3. Similar studies should be conducted in the other areas of Physics, such as heat, electricity, etc.;

4. Further researches are suggested to identify deficiencies in Physics of students in the other curricular offerings of SSPC;

5. Individuals or self-instruction should be utilized by teachers to provide the students a means whereby they can progress at their maximum rate and as far as they are able to go. This will minimize apparent deficiencies in learning.

With the foregoing studies, the researcher thought of developing an instructional material in high school science II particularly in Genetics for the second year students of Samar National School, Catbalogan, Samar.

The results and recommendations of the studies of Lacambra, Perez,and Labro point gains of the modular approach in terms of effective learning. This supports the contentions of the literature cited in the preceding paragraphs.

The studies conducted by Lacambra, Perez and Labro are related to this study because they are all concerned with the module construction and validation which can be used as an effective instructional material in teaching;

thus, improving the quality of education. However, unlike the cited studies, this study identified and selected the most important topics in high school genetics which served as the basis for instructional materials development.

Dolina,[34] in her study on the Effectiveness of Programmed Materials and Modern Mathematics for Grade Six, concluded that (1) pupils exposed to the programmed materials had a significantly greater achievement; (2) programmed instruction provides an opportunity for each pupil to learn at his own rate; and (3) programmed materials allow tardy and absent students to catch up with the lessons. She recommended that schools should make use of programmed materials to enhance the learning and teaching of mathematics in the Philippines.

Although her study was focused on Grade Six Mathematics, she strongly recommended that programmed materials be extended to other grade levels and other subjects.

In her study on programmed materials in Basic Mathematics, Roa[35] found out that such materials were effec-

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[34]Leonila Jorda-Dolina, "The Effectiveness of Programmed Materials in Modern Mathematics for Grade Six". (Unpublished Master's Thesis Divine Word University, Tacloban City, 1976), pp. 152-153.

[35]Emiliana Cruz-Roa, "A Proposed Programmed Lesson on Set Union for College Freshmen", (Unpublished Master's Thesis, Ateneo de Manila University, Manila, 1972).

tive and that the students can learn mathematical concepts and skills from them.

Hadia[36] found programmed instruction to be effective. He concluded that the programmed instruction modules were coherently suitable for the teaching of College Chemistry for which these modules were designed.

Although the studies of Roa and Hadia were associated with mathematics and chemistry, respectively, they strongly recommended that programmed instruction be tried in other subject areas.

The study of Dumas[37] on modular approach in teaching science for grade four pupils is another research work that supports this study. She came up with the following conclusions: (1) modules are effective in the teaching of concepts in science; (2) pupils using the modules achieve better than pupils who are taught by the conventional methods; (3) the modules are relevant to the needs of the pupils, and (4) the children reacted favorably to the use of modules as a teaching-learning device.

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[36]Margarito G. Hadia, "Programmed Instruction in Inorganic Chemistry at Mindanao Institute of Technology (MIT) Summer 1974: An Experiment," (Unpublished Master's Thesis, Ateneo de Davao, Davao City, 1975).

[37]Maria Dumas, "Modular Approach in Teaching Science for Grade Four Pupils," (Master's Thesis, Divine Word University, Tacloban City, 1981).

Ledesma[38] conducted a study on swine raising for secondary schools by preparing a self-instructional module. He was able to show that local educators could possibly produce reading materials whose contents are well suited to the needs of the region in general and the needs of the students in particular. He further commented that education can be delivered to the remotest corners of our country with the use of self-instructional modules.

In the study conducted by Casenas[39] on the use of modules in "Basal Reading," she concluded that modular instruction when viewed as a process of learning encourages a child to do his best, a process that reaches all children, an approach that encourages thinking and self-directed behavior.

Bohol[40] prepared a module in the study of motion in High School Physics. Based on her findings, he concluded among other things that: (1) the developed instructional

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[38]Godardo Ledesma, "Self-Instructional Module in Swine Raising for Secondary Schools", (Master's Thesis, Leyte State College, Tacloban, City, 1979).

[39]Erlinda M. Casenas, "A Sample Teaching Module Based on a Fourth Grade Basal Reader for Filipino Children", (Seminar Paper, University of the Philippines, Quezon City, 1976).

[40]Socorro O. Bohol. "Effectiveness of a Proposed Instructional Module in the Study of Motion in High School Physics", (Unpublished Master's Thesis, Divine Word University, Tacloban City 1982).

module is effective in the teaching of some concepts in motion related to typhoon in high school physics because students achieved better than the students who were taught the conventional way, (2) the developed instructional module in the study of motion in high school physics answer the need for instructional materials development in education, (3) the instructional module is a good material to supplement the basic curriculum in high school physics, and (4) the developed instructional module is a specific example for high school physics teachers to enable them to innovate their own methods and techniques.

The favorable results given in the cited related studies inspired this writer to develop and validate a module in high school genetics.

Chapter 3

METHODOLOGY

This chapter discusses the research design, population frame, sampling procedure, data gathering instruments, data gathering and validation of instruments, treatment of data, and statistical measures/tools used in this study.

Research Design

This study employed the experimental research method specifically the pretest/posttest/control group design method.

There are two (2) groups: (1) the group of 21 second year students which comprised the control group and (2) another group of 21 sophomores which composed the experimental group. The traditional approach/lecture method of teaching was applied to the former and the modular approach to that of the latter.

Pretest and posttest were given to the two groups. The pretest and posttest results in the control group were compared with that of the experimental group; then the pretest and posttest results of the control group were compared with that of the experimental group.

A documentary analysis was done. Form 137-A (Student's Permanent Record) was the main source of data

regarding the age and sex of students and the economic status of their parents.

Population Frame/Respondents

The population studied consisted of the studentry of Samar National School, Catbalogan, Samar.

For the validation of the diagnostic test, a group of third year students who have passed the Science and Technology II under the SEDP for School Year 1990-1991 were made as respondents.

A group of sophomore students who were not included in the control and experimental groups of this study served as the respondents for the identification of content difficulties in genetics (lesson 18).

Twenty one (21) second year students composed each of the control and experimental groups for the try-out of the module.

The researcher referred to various materials for the preparation of the diagnostic test and the development of the module. These materials are the works of authorities and experts in the field.

Sampling Procedure

Fifty (50) third year students were utilized as respondents for the try-out of the diagnostic test. They were chosen by employing the "fish bowl" method of random

sampling from the nineteen (19) sections in the School. Before this was done, students who were not under the SEDP Science and Technology II were not included in the population from which the respondents were chosen. The method employed here is known as purposive.

Another group of fifty (50) students were randomly selected as respondents for the identification of content difficulties in genetics (lesson 18). They came from the sophomore population. This group was selected as described in the preceding paragraph. These students were automatically not included in each of the control and experimental groups of this study to eliminate the bias factor.

The forty-two (42) students who were the subjects of the study in the control group and experimental group were more or less equated. The basis for the selection of these respondents was their final rating in Science and Technology I for School Year 1990-1991. Age and sex were also taken into consideration to attain a more or less unbiased grouping.

Both the control and experimental groups were handled by the researcher.

Instrumentation

The researcher requested for the access of the students' permanent records (Form 137-A).

Other data gathering instruments that were used in this study included the following:

Diagnostic Test. A 50-item multiple choice type of test which were prepared based on the NSEC outline for Genetics as contained in the DLC of the SEDP. This test was used to determine the difficulties that were met by the students under the topics of high school genetics.

Pretest. A 50-item test of multiple choice type given to both the control and experimental groups before each lesson. It determined the entry competency of the students.

Posttest. It made use of the pretest. It was given to both the control and the experimental groups.

To avoid the "experience factor" bias, the test items were rearranged in the posttest but the content was still identical with that of the pretest.

Data Gathering Procedure and Validation of Instruments.

The researcher employed procedure which was based from that of Lacambra's.[41] This procedure is divided into the following parts: (1) construction and validation of the diagnostic test, (2) identification of difficulties, (3) development of the module, (4) try-out of the module,

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[41]Lacambra, op. cit., p. 29.

and (5) validation of the readability of the module.

1. Construction and Validation of the Diagnostic Test.

Based on the objectives of the test a table of specification was prepared. The topic is on High School Genetics. The purpose of this table is content validity. Sixty five (65) multiple choice type test items were prepared. This number would give allowance for the possibility of rejecting the too easy and too difficult test items. The researcher asked the comments of his Head Teacher and fellow science teachers. After considering their comments and suggestions final copies were produced and subsequently given to the respondents.

A try-out was done to establish the validity of the test items in terms of: (1) the index of difficulty of each item and (2) the discriminating power of the test.

A test item analysis was conducted so that those that were found to be very easy and very difficult were rejected.

2. Identification of difficulties. The validated diagnostic test of 50 items were administered to fifty second year students of Samar National School. They were selected as discussed in "Sampling procedure".

3. Development of the Module. The basis for the content of the module was from that of the result of the

diagnostic test. The format that was followed in the development of the module contained the following features: (1) overview, (2) direction for use, (3) objective, (4) time allotment, (5) presentation, (6) evaluation, (7) reference for further reading, and (8) glossary of terms.

4. Try-out of the Module. For the try-out of the module twenty one (21) second year students of the School were used for each of the experimental and control groups. The former employed the modular approach while the latter the traditional (lecture) method of teaching. Variables that might have affected the try-out were controlled so as not to be biased with any of the two methods of teaching.

The control and experimental groups were swapped in schedule from time to time to avoid the time factor bias.

The pretest was given to both groups of students before the conduct of the session. The posttest was administered after the session.

The test items for the pretest and posttest were drawn from the test item bank of the researcher.

The results of the pretest and the posttest were tallied and tabulated for statistical treatment.

5. Validation/Evaluation of the Readability of the Module. The computations for the reading ease score (RES) and the human interest score (HIS) of the module were

referred to the study of Lacambra.[42] The RES and the HIS are the two parts of the Flesch Formula which is an instrument used in determining the readability level of developed instructional materials.

In measuring the RES the following steps were followed:

a. Choosing the sample

b. Counting the number of words

c. Counting the numbers of sentences

d. Counting the number of syllables

The average sentence length and average word length were computed. The results from the computations were used in solving the RES of the module.

In measuring the HIS, the following steps were followed:

a. Counting the personal words

b. Counting the personal sentences

From the data, the percentage personal words and personal percentage sentences were computed. The results were used in determining the HIS of the module.

Treatment of Data

The researcher sought the assistance of his adviser,

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[42] Ibid.

experts and authorities regarding the treatment of the data.

1. Test Item Analysis

a. Procedure.[43] Item analysis began after the diagnostic test has been administered. The following procedure was followed:

1. Arrange the scored test or answer sheets in order of score, from high to low.

2. Separate two subgroups of test papers. An upper group consisting of approximately 27% of the total group, who received highest scores on the test, and a lower group consisting of an equal number of papers who received lowest scores.

3. Tally the number of times each possible response to each item was chosen on the papers of the lower group.

4. Add the counts from the upper and lower groups to the keyed correct response. Divide this sum by the maximum possible sum, i.e. the sum of the number of papers in upper and lower groups. Express the quotient as a percentage, i.e. multiply the

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[43]Lecture given during the SEDP Trainor's Training by Prof. Fe S. De Guzman, U.P. Diliman. Quezon City, May 15, 1989.

decimal fraction by 100. The result is an index of item difficulty (p).

5. Subtract the lower group count of correct response from the upper group count of correct responses. Divide this difference by the maximum possible difference, i.e. the number of papers in the upper (or lower) group. This quotient, expressed as a decimal fraction, is the index of discrimination (D).

b. Formulas

$$p = \frac{R_H + R_L}{N} \qquad D = \frac{R_H - R_L}{1/2\ N}$$

Where:

p = difficulty index

D = discrimination index

R_H = Number of students in H-group (upper) who answered the item correctly.

R_L = number of students in the L-group (lower) who answered the item correctly.

N = number of students in the H-group and L-group or number of cases.

The values obtained from the computation for each item (difficulty and discrimination indices) were interpreted using the following criteria:[44]

Index of Discrimination	Item Evaluation
0.40 and up	Very good items
0.30 to 0.39	reasonably good but possibly subject to improvement.
0.20 to 0.29	marginal items, usually needing improvement
0.19 and below	poor items, to be rejected

The final form of the diagnostic test included only items with 0.30 and above index of discrimination.

As to the index of difficulty, Ebel's interpretation[45] as shown below was used.

Index of difficulty	Item Evaluation
86% - 100 %	very easy items
71% - 85%	easy items
40% - 70%	moderately difficult items
15% - 39%	difficult items
<1% - 14%	very difficult items

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[44]R. L. Ebel, Measuring Educational Achievement. (New Jersey: Prentice-Hall, Inc., 1965), p. 374.

[45]Ibid., p. 376.

Those having an index of difficulty from < 1-39 percent were considered difficult. The topics falling under this bracket were considered for the development of the module.

2. t-test for Uncorrelated Means. This was used to test the hypothesis: "There is no significant difference between the control and experimental group with respect to their mean scores in the pretest and posttest. " The formula [46] used was

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2}\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

where:

$\bar{X}_1$ = mean of the first group $= \frac{\Sigma X_1}{N_1}$

$\bar{X}_2$ = mean of the second group $= \frac{\Sigma X}{N_2}$

S_1^2 = Variance for the first group

$$= \frac{N_1 \Sigma X_1^2 - (\Sigma X_1)^2}{N_1 (N_1 - 1)}$$

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[46] Ronald Walpole, Introduction to Statistics. 3rd ed. (New York: Macmillan Publishing Co., Inc., 1982) p. 258.

S_2^2= Variance for the second group

$$= \frac{N \Sigma X_2^2 - (\Sigma X_2)^2}{N_2 (N_2 - 1)}$$

N_1 = number of samples for the first group

N_2 = number of samples for the second group

ΣX = summation of the samples (scores)

The absolute value of the computed t was compared with the tabular t value of 2.71 at 0.05 level of significance at 40 degrees of freedom.

The mean prrovides a concise description of the performance of the group in the pretest and posttest of both groups.

3. <u>t-test for Correlated Means.</u> This was used to test the hypothesis: "There is no significant difference between the pretest and posttest mean scores of the control group and the experimental group". The formula[47] used was

$$t = \frac{\bar{d}}{Sd / \sqrt{N}}$$

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[47]Ibid., p. 280.

Where :

$\bar{d}$ = mean difference between the two groups

$$\bar{d} = \frac{\Sigma d}{N}$$

Σd = summation of d

S_d = standard deviation of the difference between scores in the pretest and posttest.

N = Number of pairs

$$S_d = \sqrt{\frac{N \Sigma d - (\Sigma d)^2}{N (N-1)}}$$

The computed t value was compared with t-value of 1.725 at 0.05 level of significance at 20 degrees of freedom.

4. Flesch Formula for the Readability level of the Module.

a) Reading Ease Score = 206.835 - (1.015 x average sentence length + 0.846 x average word length).

Where:

$$\text{Ave. sentence length} = \frac{\text{No. of words in all samples}}{\text{Total No. of sentences}}$$

$$\text{Ave. words length} = \frac{\text{No. of syllables in all samples}}{\text{Total no. sample pages}}$$

b. Human Interest Score = (% Personal words per 100 words x 3.635) + (% personal sentence x 0.314)

Where:

$$\%\ \text{Personal words} = \frac{\text{Total No. of personal words in all samples}}{\text{Total No. in words in all sample pages}}$$

$$\%\ \text{Personal Sentences} = \frac{\text{Total No. of personal sentences}}{\text{Total sentences in all samples}}$$

For the interpretation of the Reading Ease Score value and the Human Interest Score value, Table 1 and Table 2 were used.

Table 1

Interpretation of Reading Ease Score

RES	DESCRIPTION OF STYLE	CORRELATED GRADE LEVEL
90 - 100	Very Easy	5th Grade
80 - 90	Easy	6th Grade
70 - 80	Fairly Easy	1st-2nd Yr. (HS)
60 - 70	Standard	3rd-4th Yr. (HS)
50 - 60	Fairly Difficult	1st-2nd Yr. (college)
30 - 50	Difficult	3rd-4th Yr. (college)
0 - 30	Very Difficult	College Graduate

Table 2

Interpretation of Human Interest Score

HIS	DESCRIPTION OF STYLE
60 - 100	Dramatic
40 - 60	Highly Interesting
20 - 40	Intersting
10 - 20	Midly interesting
0 - 10	Dull

Chapter 4

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

This chapter presents the data gathered as a result of the painstaking documentary analysis and mathematical and statistical computations. It presents the socio-economic status of the repondents together with their age, sex, and grades in their Science and Technology I. It further includes the data that compare the control group and the experimental group in terms of pretest and post-test results; readability of the module; and identification of difficulties.

Profile of the Respondents

The main source of data came from the Form 137-A or permanent records of the respondents. Careful evaluation of such records show the age and final rating of the respondents in their freshmen year. The occupation of their parents are also indicated. This has given a more or less accurate socio-economic status of the students.

Socio-economic status. Table 3 shows the occupations of the respondents' parents. This table indicates that 57.33% are fishermen, 33.33% are farmers and 66.6% are fishermen, 28.57% are farmers comprising the control and the experimental groups, respectively. These data re-

latively show that the respondents in both the control and experimental groups are more or less balance.

Table 3

Occupation of Parents of the Students in the Control and Experimental Groups

Group	Occupation		
	Fishing	Farming	Others
Control Group	12(57.14%)	7 (33.33%)	2 (9.52%)
Experimental Group	14(66.67%)	6 (28.57%)	1 (4.76%)

Age and Sex of the Respondents. As shown in Table 4, the respondents in the control group have an average age of 14.19 years old, compared to those of the experimental group (Table 5) of 14.23 years old. There are more females in both groups of respondents; 66.75% in the control group and 71.43% in the experimental group. The male percentages for both groups ate 33.3% and 28.5%, respectively. This was the closest equation that the researcher has done. Equating the two groups of respondents is important because they were statistically compared. Age and sex are well known factors that may affect their achievement level.

Table 4

Age, Sex and Final Rating in Science and Technology I of Students Composing the Control Group

Student Number	Age	Sex	Rating in Science & Tech. I (%)
1	16	Female	81
2	14	Male	80
3	14	Male	75
4	14	Female	79
5	15	Male	75
6	13	Female	78
7	14	Female	77
8	14	Female	77
9	14	Female	77
10	14	Male	76
11	17	Male	78
12	14	Female	75
13	14	Male	75
14	13	Female	79
15	14	Male	75
16	14	Female	78
17	14	Female	75
18	13	Female	77
19	15	Female	78
20	14	Female	75
21	14	Female	75
	% Male = 33.3		
Ave. =	14.19	% Female = 66.7	Ave. = 76.9

The average rating in Science and Technology I in their freshmen year is 76.9% for those in the control group and 77.19% in the experimental group. These tables show that the respondents in both groups of this study were more or less equated. This is very significant especially when the pretest and posttest results were

mathematically and statistically compared. The factor on rating was also considered because their previous achievement/preparation could affect subsequent achievement levels. The aforementioned data show that the two groups of respondents were relatively equated.

Table 5

Age, Sex and Final Rating in Science and Technology I of Students Composing the Experimental Group

Student Number	Age	Sex	Rating in Science & Tech. I (%)
1	14	Female	76
2	15	Female	79
3	13	Female	77
4	16	Female	75
5	14	Male	80
6	14	Female	80
7	13	Female	75
8	14	Female	75
9	16	Female	78
10	14	Female	76
11	14	Male	77
12	13	Male	76
13	14	Male	75
14	14	Female	75
15	16	Female	76
16	14	Female	78
17	13	Female	78
18	16	Female	80
19	14	Female	79
20	14	Male	81
21	14	Male	75
		% Male = 28.57	
Ave. =	14.23	% Female = 71.43	Ave. = 77.19

Identification Of Difficulties

There were eight (8) topics considered for the identification of difficulties in high school genetics. This was based from the textbook in Science and Technology II, lesson 18, Genetics.

Table 6 shows that seven out of the eight topics were found to be from moderately difficult to very difficult. One topic, Mendel's Experiments with Garden Peas, was found to have an index of difficulty of 70.52 which is evaluated to be an easy topic. The most difficult topic

Table 6

Computational Results for the Identification of Difficulties

Topics	Index of Difficulty	Item Evaluation
Mendel's Experiments with Garden Peas	70.52	Easy
Cross with Single Traits	38.44	Difficult
Crossing the Hybrid Plants	43.38	Moderately Difficult
Mendel's Hypothesis	36.56	Difficult
Genes and Gametes	26.39	Difficult
Knowing the Genotype	17.13	Difficult
Diagramming a Cross (Punnet Square)	2.39	Very Difficult
Dihybrid Cross	0.19	Very Difficult

was on Dihybrid Cross (0.19 index of difficulty), followed by Diagramming a Cross (2.39); Knowing the Genetype (17.13); Genes and Gametes (26.39); Mendel's Hypothesis (36.56): Cross with Single Traits (38.44); and lastly, Cross with Two Traits (43.38).

The aforementioned results paved the way for the construction of a module which served as the instructional medium in the experimental group of this study.

Readability Level of the Module

The proposed module in this study has undergone a number of revisions in order to fit its correlated grade level (Table 1) and its human interest level (Table 2).

The final form of the module yielded a final Reading Ease Score of 72.2 (Table 7). This figure is described as "Fairly Easy" and is correlated to the Ist-2nd year high school level. This means that the module is suited to the respondents who were sophomore students.

Table 7

Readability Level of the Module

	Score	Description of Style	Correlated Grade Level
Reading Ease	72.2	Fairly Easy	Ist-2nd year
Human Interest	23.5	Interesting	

Table 7 further shows that the final form of the module is found to have a human interest score of 23.5. This is interpreted as interesting to the respondents.

Testing the readability level of the proposed module, using the Flesch formulas as discussed in the Methodology (Chapter 3) was a way of validating this module.

Pretest and Posttest Results

A pretest was given to the respondents of both the control and the experimental groups to determine their entry competencies. After the throughput, a posttest (identical with the pretest) was also conducted.

The result of the pretest in the control group shows a mean of 11.238 (Table 8) as compared to the posttest results mean of 24.0476. This has resulted to a mean gain of 12.81, almost double that of the pretest mean score. This means that there was a considerable degree of improvement in their achievement.

Table 9 shows that the pretest results mean is 10.524 as compared to the posttest mean of 31.857 in the experimental group, resulting to a mean gain of 21.33. This figure is more than double that of the mean in the pretest. It means that there is much considerable improvement.

Table 8

Pretest and Posttest Results in the Control Group

Student Number	Pretest Score	Posttest Score	Mean Gain
1	3	26	23
2	12	20	8
3	6	23	17
4	7	20	13
5	20	29	9
6	12	25	13
7	6	22	16
8	11	28	17
9	12	19	7
10	15	25	10
11	7	20	13
12	21	30	9
13	8	18	10
14	11	19	8
15	14	28	14
16	12	20	8
17	6	13	7
18	14	28	14
19	13	31	18
20	16	32	16
21	10	29	19
	Σ =236	Σ = 505	Σ = 269
	$\bar{X}$ =11.238	$\bar{X}$ = 24.0476	$\bar{X}$ = 12.81

Table 9

Pretest and Posttest Results in the Experimental Group

Student Number	Pretest Score	Posttest Score	Mean Gain
1	10	39	29
2	6	34	28
3	12	37	25
4	6	30	24
5	4	29	25
6	12	41	29
7	17	29	12
8	20	33	13
9	15	33	18
10	12	28	16
11	14	39	25
12	6	34	28
13	5	28	23
14	12	32	20
15	17	36	19
16	13	30	17
17	6	29	23
18	10	27	17
19	3	19	16
20	10	29	19
21	11	33	22
	$\Sigma X = 221$	$\Sigma X = 669$	$\Sigma X = 448$
	$\bar{X} = 10.524$	$\bar{X} = 31.857$	$\bar{X} = 21.333$

The level of significance for the two-tailed test under 0.05 level of 40 degrees of freedom on the tabular value of t is 2.71. Since the absolute computed value of t is 0.50, being less than the tabular value, the null hypothesis that "there is no significant difference between the control group and the experimental group with respect to their mean scores in the pretest" is accepted. This means that the entry competencies of both are relatively the same. The difference is not significant enough. Further, since the absolute computed value of t is 4.99, being greater than the tabular value (as cited above), the null hypothesis "there is no significant difference between the control group and the experimental group with respect to their mean scores in the posttest" is rejected. This means that the achievement level in the experimental group is much better than in the control group. There is greater learning in the former than in the latter method of teaching.

On the other hand, the level of significance for a two-tailed test under 0.05 level of 20 degrees of freedom on the tabular value of t is 1.725. Since the absolute computed value of t is 10.12 in the control group and 18.88 in the experimental group, being both greater than the tabular value, the null hypothesis that "there is no significant difference between the Pretest and Posttest

mean scores of the control group and the experimental group" is rejected. This means that there is improvement in the performance in both groups of respondents; therefore, learning took place.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary, findings, conclusions and recommendations of this study.

Summary

This study was conducted to develop and validate a module in high school genetics for the Samar National School, Catbalogan, Samar.

The proposed module was intended to be used by both the Science and Technology II teachers and sophomore students of said school.

The results of this study could humbly serve as feedback mechanisms to proper school authorities and administrators for the alleviation of poor quality education.

Specifically, this study sought to answer the following questions:

1. What are the socio-economic status, age and sex of the respondents in the

    1.1 Control group?

    1.2 Experimental group?

2. What topics in High School Science II (Genetics) can be modularized?

3. Is the readability level of the developed module

appropriate to the second year high school students?

4. What are the mean scores of the control and experimental groups in the

4.1 Pretest?

4.2 Posttest?

5. What is the mean gain in the

5.1 Control group?

5.2 Experimental group?

6. Is there a significant difference between the control and the experimental groups with respect to their mean scores in the

6.1 Pretest?

6.2 Posttest?

7. Is there a significant difference between the Pretest and the Posttest mean gain of the

7.1 Control group?

7.2 Experimental group?

This study employed the experimental research method specifically the pretest/posttest/control group design method.

The data were gathered through the use of Form 137-A (Permanent Records of Students). Other sources of data included the pretest and posttest results, diagnostic results, T-test for independent and dependent mean results and the Flesch Formula computational results.

The researcher referred to various and numerous books of foreign and local authors, documents, dissertations, theses, magazines, newspapaers and other publications which reinforced the meat and substance of this study.

The subjects of this study were composed of twenty-one second year students for the control group and another set of students of the same quantity and year level for the experimental group.

The researcher employed the traditional method of teaching in the former and the modular approach of teaching in the latter.

Necessary permissions from the administrators of the School were sought before the conduct of this study.

The statistical tools employed in this study were the Flesch formulas, mean, test item analysis formula, and t-test for independent and dependent means.

Findings

The findings are herewith presented in accordance with the order of the specific questions.

The basis for the determination of the socio-economic status of the respondents was the occupation of their parents as reflected in the Form 137-A (Permanent Records of Students). This instrument is also the source of data for the average age and sex of said respondents.

Majority of the parents of the respondents in the control group are fishermen (57.14%) and farmers (33.33%) as compared to those in the experimental group whose parents are also fishermen (66.6%) and farmers (28.57%).

The average age of the control group is 14.19 years old while that of the experimental group is 14.23 years old.

There are more females in both groups, 66,75 % in the control group and 71.43% in the experimental group.

Based from the results of the computation for the index of difficulty, the following topics were found to be suited for modularization because their indices of difficulty fell within the range of less than 1% to 39%.

2.1 Dihybrid Cross (index of difficulty: 0.19)

2.2 Diagramming a Cross (2.39)

2.3 Knowing the Genotype (17.13)

2.4 Genes and Gametes (26.39)

2.5 Mendel's Hypothesis (36.56)

2.6 Cross with Single Traits (38.44)

2.7 Cross with Two Traits (43.38)

The readability level of the module was computed based on the Flesch Formula: RES and HIS.

The Reading Ease Score was computed to be 72.2 and the Human Interest Score was found to be 23.5. Respectively, it means that the module was appropriate to second

year students and it was interesting.

The mean score in the pretest of the control group is 11.238 while its posttest mean is 24.0476.

The pretest mean score of the experimental group is 10.524 while its posttest mean score is 31.8576. This means that a considerable achievement level was reached.

The computational results show that the control group had a mean gain of 12.81 while that of the experimental group is 21.33 Both groups have achieved considerable improvement in learning competency.

The absolute computed t value of 0.50 is less than the tabular t-value of 2.71 at 0.05 level of significance at 40 degrees of freedom. This means that the null hypothesis which states that there is no significant difference between the control and the experimental groups with respect to their mean scores in the pretest is accepted. The entry competencies of both the control and experimental groups are the same.

The absolute computed t value of 4.99 is greater than the tabular t value of 2.71 at 0.05 level of significance at 40 degrees of freedom. It means that the null hypothesis that "there is no significant difference between the control and the experimental groups with respect to their mean scores in the posttest " is rejected. This reveals that the achievement level in the experimental

group is better than that in the control group. There was better delivery of goods in the former.

The absolute computed value of t in the control group and the experimental group are 10.12 and 18.88 respectively, which are both greater than the tabular t value of 1.725 at 0.05 level of significance at 20 degrees of freedom; hence, the above cited null hypothesis is rejected. That means that there were improved performances of the students in both the control and experimental groups. There was learning.

Conclusions

In the light of the aforementioned findings, the researcher had formulated the following conclusions:

1. The sophomore students of Samar National School showed varying degrees of difficulty in high school genetics, specifically on the Mendelian Principles of Heredity and their present-day interpretations. Students in both groups learned much from said topics in High School Genetics.

2. The control group and the experimental group had the same level of entry competencies.

3. There is a significant difference between the posttest mean scores in the control and experimental groups. Therefore, the modular approach of teaching is more effective than the traditional method as far as the

above cited topics in High School Genetics are concerned.

4. There is a significant difference between the pretest and posttest mean scores in both the control group and the experimental group.

5. The module is appropriate and interesting for the second year high school students in terms of readabitity level.

Recommendations

Based on the foregoing conclusions, the researcher recommend the following:

1. Seminar-workshops on module preparation should be conducted for teachers to be properly trained in module making.

2. Trained teachers should prepare modules in subject areas of their expertise to increase the achievement level of the students.

3. Students should be exposed to modular instruction for them to be developed as independent and self-reliant individuals.

It is further recommended that the module used in this study be used and evaluated in other schools to verify its effectiveness.

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APPENDICES

APPENDIX A

THE MODULE

OVERVIEW

You might have heard of the terms like test tube baby, cloning, artificial insemination, chromosomal mapping, genetic engineering, and many others. These terms are all associated with the science called Genetics. This branch of biology is now fast becoming one of the most popular bodies of knowledge. In fact, problems in court cases have been settled because of the knowledge of genetics.

Genetics is relatively a new science. The discovery of the experimental results of Gregor Mendel, who is considered as the Father of Genetics, paved the way for the interest of scientists in this field.

In this module, you will encounter some of the techniques employed in genetics to solve problems on crosses. Some of the works of Mendel are cited and it would be better if you research more on his life and works.

The Mendelian principles of heredity are discussed together with their present-day interpretations.

This module includes activities that aim to make you understand the lesson better.

DIRECTIONS FOR USE

This module was developed to help you understand better the Mendelian principles of heredity including their present-day interpretations. In order to benefit most from this module you are required to strictly follow the sequence of the topic presented because most of them are prepared in such a way that mastery of each topic depends upon your success in the next.

It is a must for you to perform all the activities in this module because they will help you learn more and strengthen your understanding of the concepts discussed.

Do not proceed to the next topic, unless you have mastered the present lesson.

Questions marked with this / / followed by a number are checkup questions in each activity. They should all be answered in a separate sheet of paper or preferably a notebook. These questions will help you measure how much you learn from this module.

At the end of this module is a glossary of terms that you can refer to and a list of reference materials that you can consult for your further enrichment.

After you have made use of this module, you should have been able to:

1. discuss similarities and variations that exist among organisms;

2. describe Mendel's experiment on garden peas as a classic example of a scientific work;

3. differentiate

3.1 homozygous trait from heterozygous trait

3.2 dominant trait from recessive trait

3.3 genotype from phenotype; and

4. solve problems in genetics.

TIME ALLOTMENT: Five meetings of one hour each

PRESENTATION

Variation

Have you tried observing youself, your parents, sisters, brothers, and even your classmates? Do you notice any similarity between you and them? With whom do you look like most: Your mother or your father? Why do you think there are similarities and variations among people?

These questions could be answered if you study a branch of biology that deals with the transmission of characteristics. This science is called genetics.

Activity 1. Yourself and Other

In this activity, you will record observations about yourself and your classsmates. You will take note of the similarities and differences that exist between you and your classmates. You can also perform this activity in your home by comparing yourself with your brother, sisters, father, and mother.

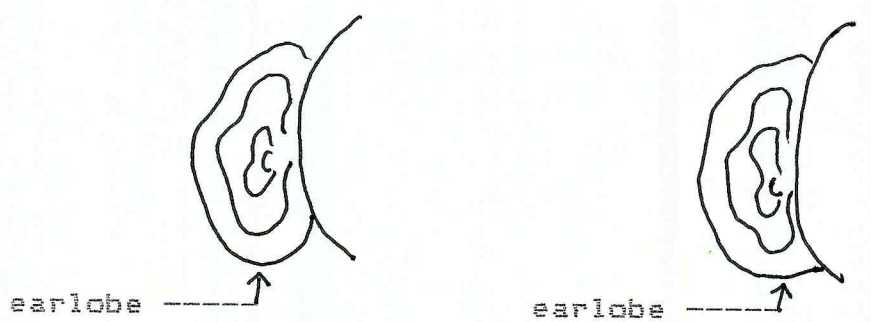
Procedure

1. With the list of traits given in Table 1, identify the features you have.

Table 1

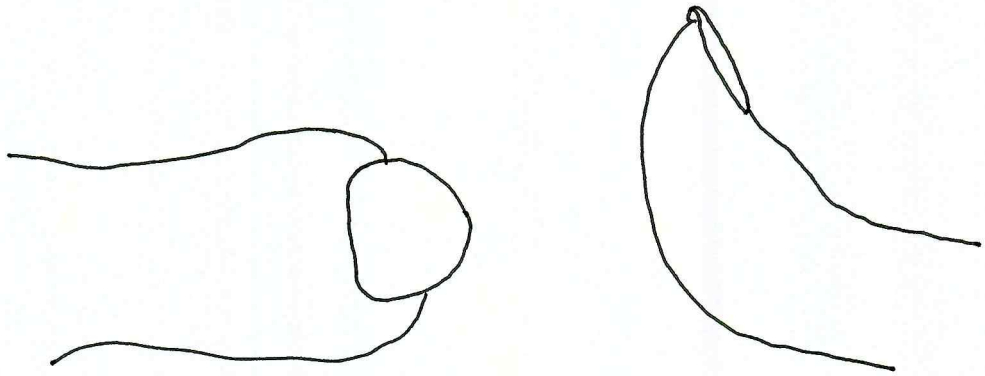
TRAITS	APPEARANCE
1. Dimple	with dimple or without dimple
2. Handedness	Rigth handed or lefthanded
3. Earlobe	Attached or unattached
4. Human hand	Clubbed finger or hitchhiker's thumb
5. Hair	straight or wavy/kinky

2. Find out if your classmate has the appearances as described in Table 1 or not. Refer to Figure 1 for the appearances of earlobes and Figure 2 for those of the human hand.



(a) Unattached Earlobe (b) Attached Earlobe

Figure 1 TYpes of Earlobes



a.) Clubbed figer b.) Hitchhiker's thumb

Figure 2 Kinds of Thumbs

3. Copy Table 2 and record your observations. Check opposite each appearance which is observable.

Table 2

Appearances	My Classmate	Myself
With dimple		
Without dimple		
Righthanded		
Lefthanded		
Attached earlobe		
Unattached earlobe		
Clubbed finger		
Hitchhiker's thumb		
Straight hair		
Wavy/Kinky hair		

/ / 1. Which appearances are most common to both of you?

/ / 2. Which appearances differ you most from your classmate?

3. Compare also yourself with the members of your family as regards the appearances listed in Table 1.

The characteristics which are most common between your classmate and yourself are called similarities while those that differ you most from him are called variations.

If you make comparisons as you have done in No. 3 among your family members, you might observe that you could either look like your father or your mother or both of them. These similarities and difference are carried by what Gregor Mendel termed as "factors" from your parents to your brothers and sisters and yourself through the process of reproduction. This is true to all organisms that reproduce sexually. These factors are now called genes. They are found in the chromosomes inside the nucleus of the cell. They are passed through the gametes: sperm cell and egg cell.

Mendelian Principles of Heredity and Their Present Day Interpretations

During the middle part of the nineteenth century, Gregor Mendel, an Austrian monk conducted various experiments in his garden in the monastery. He was very curious

about and interested in the variations that his garden peas exhibit. He observed at least seven traits as listed in Table 3.

/ / Research on the biography of Gregor Mendel/.

Table 3

Traits in Garden Peas as Observed by Mendel

Traits	Appearances
1. Seed shape	round or wrinkled
2. Seed color	yellow or green
3. Seed coat color	colored or white
4. Pod shape	inflated or constricted
5. Pod color	green or yellow
6. Flower position	axial or terminal
7. Stem length	long or short

Before you study further the results of Mendel's experiment, take note first of the symbols which are used in this lesson.

P_1 = parents in the first generation

F_1 = offspring in the first generation

P_2 = parents in the second generation

F_2 = offspring in the second generation

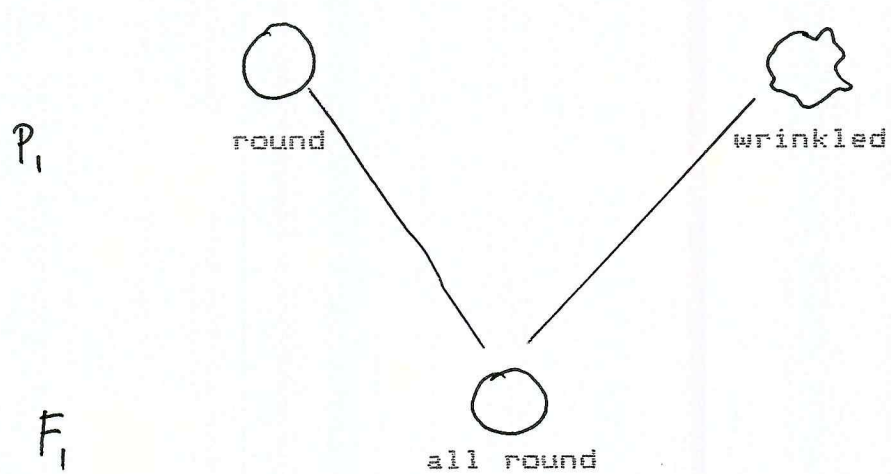
♂ = male

♀ = female

X = parents are crossed

Mendel observed that each of the seven traits occurred in two contrasting forms. For example, the seed shape is either round or wrinkled; the seed color is either yellow or green, and so on.

Because of such observations, Mendel tried to perform artificial pollination to make sure that the right kind of pollen grain fertilizes the right kind of ovule. He cross-pollinated garden peas of contrasting forms. When he cross-pollinated two (P_1) contrasting forms of one of these traits, he found out that the offspring (F_1) were alike and resembled one of the two parents (see Figure 3).



P_2 (from F_1)

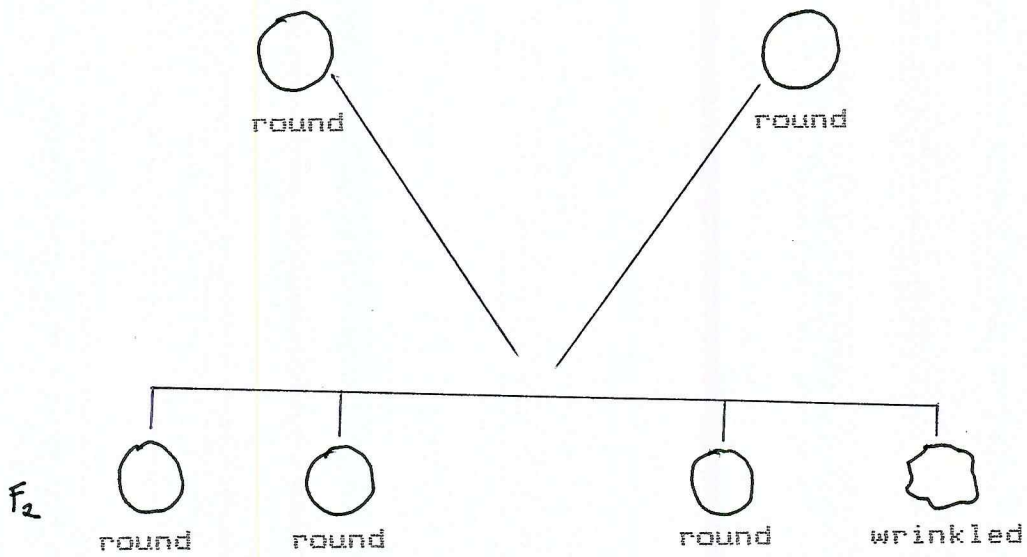


Figure 3. Results of Mendel's cross of garden peas of contrasting seed shape.

When Mendel selected two from F_1 and cross-pollinated them (P_2) he observed that the seed shape of most of the F_2 offspring were round and very few were wrinkled. He repeated his experiments several times involving the other traits as listed in Table 3. He found out that the results were relatively the same. Table 4 shows other results of Mendel's experiments/crosses.

Table 4

Mendel's Results from Crosses Involving Single Character Differences

P Characters	F_1	F_2	F_2 Ratio
1. Round x Wrinkled Seeds	all round	5,474 round: 850 wrinkled	2.96:1
2. Yellow x green seeds	all yellow	6,022 yellow: 2,001 green	3.01:1
3. Red x white flower	all red	705 red: 224 yellow	3.15:1
4. Inflated x Constricted pods	all inflated	882 inflated: 299 constricted	2.95:1
5. Green x Yellow pods	all green	428 green : 152 yellow	2.82:1
6. Axial x Terminal flowers	all axial	651 axial: 207 terminal	3.14:1
7. Long x short stems	all long	787 long: 227 long	2.84:1

Mendel's Hypotheses

With the above observations, Mendel formulated the following hypotheses:

First hypothesis: In each organism there is a pair of factor which controls the appearance of a particular trait.

Today, the term "factor" is now called gene and the phrase "pair of factors" is now termed as alleles.

These "factors" according to Mendel, control the appearance of particular traits in an organism and these

"factors" are always "paired."

Second hypothesis: Member of the pair of factors may hide or prevent the appearance of the other factor.

Mendel made this hypothesis in the light of his observations as shown in Table 4 that there is an instance when one appearance does not show in the F_1 but would later appear in the F_2. The member of the pair of factors (alleles) that Mendel cited is now called as dominant trait and the one that is hidden is the recessive trait. For example, in Figure 3, the dominant trait is round while the recessive trait is wrinkled. Round is dominant because it prevented the appearance of the wrinkled trait which is the recessive trait.

Third hypothesis: In successive generations, each factor is transmitted unchanged. This means that the "factor" for round in the P_1 generation is the same as that in the F_1 generation.

Fourth hypothesis, which is now known as Mendel's first law of inheritance or the law of segregation: During gamete formation, the pair of factors segregates or separate from each other. The gamete formation that Mendel referred to here is now called as meiosis. You could probably still recall the processes involved or what happen during meiosis in your lesson on reproduction.

Genes and Gametes

In the preceeding discussions you have learned that genes that are trasmitted from the parents to the offsring are paired and they are called as alleles and these are carried by the sperm cell and the egg cell from one generation to another.

Some alleles are identical and they are called as homozygous. Alleles that are not the same are heterozygous. Homozygous are purebreds while heterozygous are hybrids.

In genetics, it is more convenient to use letters to represent genes, alleles, and dominant/recessive traits. With regards to this, it is very important for you to remember these rules:

Rule 1. Use one kind of letter only to represent one trait, even if this trait results in two appearances (see Table 3 again).

Rule 2. The first letter of the dominant trait is used to represent the trait regardless of the first letter of the recessive trait.

Rule 3. Dominant trait is represented by a capital letter and a small letter for the recessive trait. (Both letters should be of the same kind (Rule 1).

Rule 4. Since genes are paired or in the form of an allele, it would follow that you will use two letters but

of the same kind (not different kinds of letters) as stated in Rule 1.

4.1 For heterozygous alleles: one is capital, the other is small.

4.2 For homozygous alleles: Letters are either both capital or both small. Both are capital if homozygous dominant and both small letters if homozygous recessive. Take note that recessive traits are always in their homozygous condition.

Let us now apply the rules just cited by means of an example as shown below.

Suppose a garden pea has a long stem and the other pea has a short one. The appearance of a long stem is dominant while that of short one is recessive. How do you represent in letters a pea of long stem and another with a short stem?

Solution: appearances: 1. long (dominant)

2. short (recessive)

Remember that long and short refer to one trait, that is stem length, therefore we will use one kind of letter only (Rule 1). We will use letter l because this is the first letter of the dominant long (Rule 2). Long is represented by L while short is l (Rule 3).

long = L

short = l (not s because of Rule 1)

Following Rule 4:

LL = homozygous

Ll = heterozygous

ll = homozygous recessive

When we speak of long, short, red, brown. axial, terminal, beautiful, ugly, etc., these are referred to the phenotype of the organism. All the things that you feel and see are the phenotypes of the organism and the pair of genes or alleles (represented by letters) that are responsible for these appearances are the genotypes of said organism. For example, long and short are the phenotypes of the stem length of garden peas while homozygous long, heterozygous long, and homozygous short (which are represented by LL, Ll, and ll, respectively) are their genotypes.

Activity 2 Practice with Genotypes and Phenotypes

Given: 1. Round is dominant over wrinkled

2. Axial is dominant over terminal

/ / 5. Choosing a letter, represent the traits in number 1 and number 2 if the pea is

a. homozygous dominant

b. heterozygous dominant

c. homozygous recessive

/ / 6. Give the phenotypes of a, b, and c, in No. 1 and No. 2.

/ / 7. Explain why an individual must be homozygous if he is to exhibit a recessive trait.

If you have mastered in determining the genotypes and the phenotype of a particular trait, you can now determine the kind of gametes of the organism. Heterozygous genotypes have two kinds of gametes while homozygous have one kind only for every trait. For example, Ll have (L) and (l) as gametes; LL has (L) as its gamete, and ll has (l) as its gamete.

Cross With Single Traits

When a cross involving one or single trait only is considered, the cross is said to be a monohybrid cross. Figure 3 is an example.

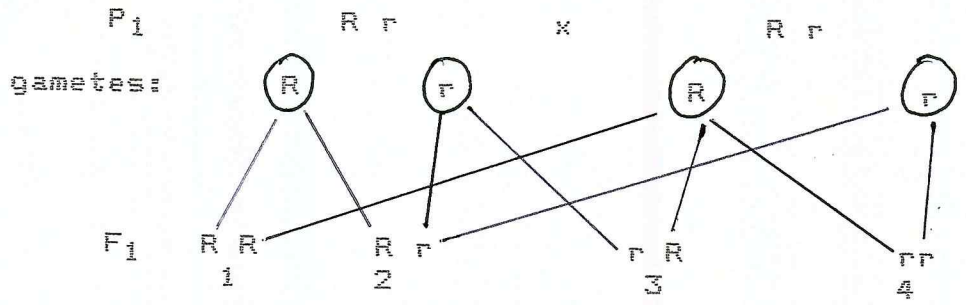
Let us take another example of a monohybrid cross.

Rr x Rr

gametes: (R) (r) x (R) (r)

There are two ways of solving our example above: (1) the Fork Method and (2) using the Punnet Square Method.

The Fork Method



F_1 genotypes 1 – homozygous red (RR)

2 – heterozygous red (Rr)

3 – heterozygous red (rR)

4 – homozygous white (rr)

F_1 Phenotypes: 1 – red

2 – red

3 – red

4 – white

F_1 genotypic ratio: 1 (RR): 2 (Rr): 1 (rr) or simply 1:2:1

F_1 phenotypic ratio: 3 (red): 1 (white) or simply 3:1

The Punnet Square Method

(Rr) ♂ \ (Rr) ♀	R	r
R	R R	R r
r	r R	r r

Activity 3. The Monohybrid Cross

Illustrate a cross between a homozygous dominant axial garden pea and a homozygous recessive pea.

/ / 8. Give the genotype and phenotype of the offspring.

Cross With Two Factors (Dihybrid Cross)

When you cross two pairs of genes of organisms, it is called a dihybrid cross. It is much easier to solve a dihybrid cross if you employ the Punnet Square Method. But before you can solve a dihybrid cross, it is a must for you to have mastered in determining the gametes of the parents.

To determine the gametes, the last hypothesis of Mendel is applied. The hypothesis states that "the distribution or assortment of one pair of factors is independent of the distribution of the other pair." For example, if we have a genotype like RRLl:

RR stands for homozygous round

Ll means heterozygous long

To determine the gametes:

R R L l = 1 with 3 = (RL)

1 2 3 4 = 1 with 4 = (Rl)

= 2 with 3 = (RL)

= 2 with 4 = (Rl)

Activity 4. A Dihybrid Cross

Given the cross RrLl x RrLl, copy and fill up the Punnet Square in Figure 4. After completing the diagram, answer the given questions below Figure 4.

Note: P = RrLl x RrLl

♂ \ ♀				

Figure 4. A Punnet Square

/ / 9. What are the Male gametes?

/ / 10. What are Female gametes?

/ / 11. What proportion of the offspring will have the following phenotypes: RL, RL, rL, and rl?

/ / 12. How many kinds of genotypes will the offspring have?

/ / 13. What is the probability that an individual will have genotypes of RRll, RrLl, rrll, RRLL?

CONGRATULATIONS!

**You have now completed the Module.
Have you successfully achieved the
objectives stated on the second page
in the module? If your answer is
yes then do the posttest.
If not, go back and use the module
again until you have mastered it.**

GLOSSARY OF TERMS

Allele. Either of a pair of genes located at the same position on both members of a pair of chromosomes and conveying characteristics that are inherited alternatively.

Artificial insemination. The impregnation of a female by artificial introduction of semen taken from a male.

Chromosomal Mapping. It is a technique of representing the general appearance, including the size, number, and shape of the set of somatic chromosomes.

Cloning. The technique of producing a genetically identical duplicate of an organism by replacing the nucleus of an unfertilized ovum with the nucleus of a body cell from the organism.

Dihybrid Cross. It is a cross between individuals that involves two pairs of genes.

Dominant traits. Designating or relating to that one of any pair of allelic hereditary factors which, when present in the germ plasm, prevents the appearance of the other and appears in the organism.

Gametes. It also means sex cells (sperm cell and egg cell).

Genes. Any of the units occuring at specific points on the chromosomes, by which hereditary characters are transmitted from parents to offspring.

Genetic engineering. Any human manipulation of the genetic code in an attempt to effect biological improvement in a species of animal or plants.

Genetics. It is the branch of biology that deals with heredity and variation in similar or related animals.

Genotype. It is the particular combination of genes present in the cells of an individual.

Heterozygous. Having two differentn alleles of a given genes.

Homozygous. Having two doses of the same allele of a given gene.

Hybrid. It is a cross between two genetic types.

Meiosis. A process of nuclear division in which the number of chromosomes is reduced by half.

Monohybrid. It is a cross between two individuals that involve one pair of genes.

Offspring. A descendant/child or descendants/children collectively.

Phenotype. An organism's physical appearance, which results from the interaction of its genotype and the environment.

Pollination. The transfer of pollen grains from a stamen to the upper tip of the pistil of a flower.

Purebred. Belonging to a recognized breed with characters maintained through generations of unmixed descent.

Recessive. Designating or relating to that one of any pair of allelic hereditary factors which, when both are present in the germ plasm, remains latent or it is hidden. It is expressed only in homozygous individuals.

Variation. A deviation from the usual or parental type in structure or form.

References for Further Reading

BSCS, Biology for Philippines High Schools, Quezon City University of the Philippines, 1965.

Burns, George W. The Science Of Genetics: An Introduction to Heredity, New York: Macmillan Publishing Co., Inc., 1984.

DECS, Science and Technology II, Quezon City: Instructional Media Corporation, 1990. (Trial and Final Editions).

De Robertis, E.D.P. Cell Molecular Biology. Philadephia: Lee and Febiger, 1987.

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MEC. Living Things and Their Environment, Manila: GMS Publishing Corp., 1978.

Vega, Milagros A. Biology in a Changing Philippines, Manila: Goodwill Trading Co., Inc., 1978.

Ville, Claude A. Biology, Philadephia: W.B. Saunders Company, 1972.

APPENDIX B

Republic of the Philippines
SAMAR STATE POLYTECHNIC COLLEGE
Catblogan, Samar

May 7, 1991

The Dean of Instruction and Related Services
Samar State Polytechnic College
Catbalogan, Samar
(Thru Channels)

S i r :

In my desire to start writing my thesis proposal, I have the honor to submit for your approval one of the following research problems, preferrably problem No. 1.

1. DEVELOPMENT AND VALIDATION OF A MODULE IN HIGH SCHOOL SCIENCE II (GENETICS)

2. DEVELOPMENT AND VALIDATION OF SELF-INSTRUCTIONAL MATERIALS IN HIGH SCHOOL GENETICS

3. RECYCLING OF BIODEGRADABLE WASTE INTO PROFITABLE COMMODITIES.

I hope for your early and favorable action on this request.

Very truly yours,

(SGD) PEDRITO G. PADILLA

Recommending Approval:

(SGD)TERSITO A. ALIPOSA, Ph. D./Ed.D.
Chief, Research/Extension/Publication

APPROVED:

(SGD) SENECIO D. AYONG, DPA/Ed.D.
Dean, Instruction and Related Services

APPENDIX C

Republic of the Philippines
SAMAR STATE POLYTECHNIC COLLEGE
Catbalogan, Samar

SCHOOL OF GRADUATE STUDIES

APPLICATION FOR ASSIGNMENT OF ADVISER

NAME: Padilla Pedrito Gasmen
Surname First Name Middle name

CANDIDATE FOR DEGREE: Master of Arts in Education

AREA OF SPECIALIZATION: Administration and Supervision

TITLE OF PROPOSED THESIS/DISSERTATION: Development and Validation of Module in High School Science II (Genetics).

(SGD) PEDRITO G. PADILLA
Applicant

Dr. SENECIO D. AYONG
Name of Designated Adviser

APPROVED:

(SGD) SENECIO D. AYONG, DPA/ED.D.

APPENDIX D

SAMAR STATE POLYTECHNIC COLLEGE
Catblogan, Samar

December 12, 1991

The Dean of Graduate Studies
Samar State Polytechnic College
Catbalogan, Samar

S i r :

In have the honor to request that I be scheduled on December 20, 1991 to defend my thesis proposal, entitled "DEVELOPMENT AND VALIDATION OF A MODULE IN HIGH SCHOOL SCIENCE II (GENETICS).

In this connection, I am submitting herewith five copies of my thesis proposal for distribution to the Dean and the panel members.

I hope for your early and favorable action on this request.

Very truly yours,

(SGD) PEDRITO G. PADILLA

Recommending Approval:

(SGD)SENECIO D. AYONG DPA/Ed.D.
Adviser

APPROVED:

(SGD) SENECIO D. AYONG, DPA/Ed.D.
Dean, Instruction and Related Services

APPENDIX E

Republic of the Philippines
Department of Education, Culture and Sports
Region VIII
Division of Samar
SAMAR NATIONAL SCHOOL
Catblogan, Samar

January 06, 1992

The PRINCIPAL
Samar National School
Catbalogan, Samar

Dear Ma'am:

In have the honor to request permission to conduct a try-out for my constructed diagnostic test among the selected third year students of this school to meet my partial requirements for the degree Master of Arts in Education which course I am pursuing in the Samar State Polytechnic College.

Anticipating your favorable response and consideration, I remain

Very truly yours,

(SGD) PEDRITO G. PADILLA

Recommending Approval:

(SGD)CRESCENCIA A. CILLO
SSHT -VI

APPROVED:

(SGD) ELENITA L. ADVINCULA
OIC- Principal

APPENDIX F

Republic of the Philippines
Department of Education, Culture and Sports
Region VIII
Division of Samar
SAMAR NATIONAL SCHOOL
Catblogan, Samar

January 09, 1992

The PRINCIPAL
Samar National School
Catbalogan, Samar

Dear Ma'am:

In have the honor to request permission to have access to the records of second year students especially to their Form 137-A. This is in connection of meeting my partial requirements for the degree Master of Arts in Education which course I am pursuing in the Samar State Polytechnic College.

Thank you very much for the anticipated favorable response.

Very truly yours,

(SGD) PEDRITO G. PADILLA

Recommending Approval:

(SGD)CRESCENCIA A. CILLO
SSHT-VI (S & T)

APPROVED:

(SGD) ELENITA L. ADVINCULA
OIC- Principal

APPENDIX G

Republic of the Philippines
Department of Education, Culture and Sports
Region VIII
Division of Samar
SAMAR NATIONAL SCHOOL
Catblogan, Samar

January 06, 1992

The PRINCIPAL
Samar National School
Catbalogan, Samar

Dear Ma'am:

In have the honor to request permission to conduct a diagnostic test among selected Second year students in this school to meet my partial requirements for the degree Master of Arts in Education which course I am pursuing in the Samar State Polytechnic College.

Anticipating your favorable response and consideration, I remain

Very truly yours,

(SGD) PEDRITO G. PADILLA

Recommending Approval:

(SGD)CRESENCIA A. CILLO
SHT -VI

APPROVED:

(SGD) ELENITA L. ADVINCULA
OIC- Principal

APPENDIX H

Republic of the Philippines
Department of Education, Culture and Sports
Region VIII
Division of Samar
SAMAR NATIONAL SCHOOL
Catblogan, Samar

January 06, 1992

The PRINCIPAL
Samar National School
Catbalogan, Samar

Dear Ma'am:

In have the honor to request permission to conduct an experimental study on the use of a module among pre-selected second year students of this school to meet my partial requirements for the degree Master of Arts in Education which course I am pursuing in the Samar State Polytechnic College.

Anticipating your favorable response and consideration, I remain

Very truly yours,

(SGD) PEDRITO G. PADILLA

Recommending Approval:

(SGD)CRESCENCIA A. CILLO
SSHT-VI (S&T)

APPROVED:

(SGD) ELENITA L. ADVINCULA
OIC- Principal

APPENDIX I

TABLE OF SPECIFICATION

Content	Time Allotment	% of No. of Items	SKILL						To-tal
			Know-ledge	Comprehension	Application	Analysis	Synthesis	Evaluation	
Mendel's Experiments	30 min	10	1	2	2	1	1		7
Cross with Single Traits	30 min	10	1	2	2	2			7
Crossing the Hybrid Plants	30 min	10	1	2	2		2	1	7
Mendel's Hypothesis	30 min	10	1	2	2	1	1		7
Genes and Gametes	30 min	10	1	2	3			1	7
Knowing the Genotype	30 min	10	1		2	2	1	1	7
Diagramming a Cross	60 min	20	1	2	3	3	1	1	11
Dihybrid Cross	60 min	20	1	3	3	2	1	1	12
TOTAL	300 min	100	9	14	19	11	7	5	65

APPENDIX J

Item Analysis Worksheet

Item Number	Number of Answers R_H	Number of Answers R_L	Difficulty Index $P = \frac{R_H - R_L}{N}$	Discrimination index $D = \frac{R_H - R_L}{1/2\ N}$	Number Choosing each option: Omit H_o	Omit L_o	A H_o	A L_o	B H_o	B L_o	C H_o	C L_o	D H^o	D L^o

APPENDIX K

Item Analysis Summary Table

Item No.	Content Area	P	D	Behavioral Classification		Item as a Whole		
				P	D	Accept	Revise	Reject

APPENDIX L

SAMAR STATE POLYTECHNIC COLLEGE
Catblogan, Samar

March 2, 1991

The Dean of Graduate Studies
Samar State Polytechnic College
Catbalogan, Samar

S i r :

I have the honor to request that I be scheduled on March 4, 1992 to defend my thesis entitled "DEVELOPMENT AND VALIDATION OF A MODULE IN HIGH SCHOOL SCIENCE II (GENETICS).

In this connection, I am submitting herewith six copies of my thesis for distribution to my adviser, the chairman and the members of the panel of examiners.

I hope for your early and favorable action on this request.

Very truly yours,

(SGD) PEDRITO G. PADILLA

Recommending Approval:

(SGD)SENECIO D. AYONG DPA/Ed.D.
Adviser

APPROVED:

(SGD) SENECIO D. AYONG, DPA/Ed.D.
Dean, Instruction and Related Services

APPENDIX M

PRETEST/POSTTEST ITEMS

Direction: Select the best answer. Write the letter only on a separate sheet of paper.

----1. Who is considered as the Father of Genetics?

a. Charles Darwin c. Louis Pasteur

b. Gregor Mendel d. Robert Hooke

----2. It refers to the differences that exist among organism.

a. heredity c. transmission

b. variation d. speciation

-----3. It is a hidden character.

a. dominant c. homozygous

b. recessive d. heterozygous

-----4. Which of the following does not describe Mendel's experiments?

a. He used large numbers of organisms.

b. He studied many traits at a time.

c. He used rules of probability to analyze the results.

d. He put together the results of identical experiments.

-----5. Hybrids also mean _____

a. heterozygous c. dominant

b. homozygous d. recessive

_____6. Which of the following is a phenotype?

a. seeds within pods c. cone-bearing gymnosperns

b. aquatic plants d. corn plant with small ears

_____7. Which of the following assort independently?

a. genes c. gametes

b. chromosomes d. body cells

_____8. In Mendel's experiments, pure-breeding plants with alternative experiments for one trait were cross-pollinated. Only one expression of the traits appeared in the F_1 offspring. What did this result indicate?

a. One of the gametes produced by a plant did not carry the trait.

b. Some of the gametes were not fertilized.

c. One expression of the traits was dominant.

d. One expression of the traits was not transmitted to the offspring.

Use the following facts to answer questiona 10 to 12. In garden peas, round (R) is dominant to wrinkled (r); yellow (Y) is dominant to green (y).

_____9. How many kinds of gametes could be produced by a RRYY plant?
a. 1 b. 2 c. 3 d. 4

____10. How many kinds of gametes could be produced by a rrYy plant?

a. 1 b. 2 c. 3 d. 4

____11. How many kinds of gametes could be produced by RrYy?

a. 1 b. 2 c. 3 d. 4

____12. Are there how many kinds of the male gametes (P_1)?
a. 2 b. 3 c. 4 d. 5

Use the following facts to answer questions 13 to 24

Axial = dominant (A)
terminal = recessive (a)

P_1 AA x Aa

F_1 (1) AA (2) Aa (3) aA (4) aa

----13. How many female gametes (P_1)?

a. 1 b. 2 c. 3 d. 4

Give the phenotype of:

----14. Offspring number 1.

a. axial
b. terminal
c. axial-terminal
d. terminal-axial

----15. Offspring number 2.

a. axial
b. terminal
c. axial-terminal
d. terminal-axial

----16. Offspring number 3.

a. axial
b. terminal
c. axial-terminal
d. terminal-axial

----17. Offspring number 4.

a. axial
b. terminal
c. axial-terminal
d. terminal-axial

Give the genotype of:

----18. Offspring number 1.

a. homozygous dominant
b. Heterozygous dominant
c. homozygous recessive
d. both b and c

----19. Offspring number 2.

a. homozygous dominant

b. Heterozygous dominant

c. homozygous recessive

d. both b and c

----20. Offspring number 3.

a. homozygous dominant

b. Heterozygous dominant

c. homozygous recessive

d. both b and c

----21. Offspring number 4.

a. homozygous dominant

b. Heterozygous dominant

c. homozygous recessive

d. both b and c

----22. (2pts) What is the phenotypic ratio?

a. 3:1 c. 2:1

b. 2:3 d. 1:1

----23. (3pts) How about the genotypic ratio?

a. 3:1:1 c. 1:2:1

b. 1:2:1 d. 2:2:5

Questions 24 and 25 are about the following:

Mendel's experiment showed that when a pea plant with inflated pods was cross-pollinated with another pea plant with constricted pod, all offspring had inflated pods.

----24. (5pts) Which of the diagrams below represents the alleles of the following?

a. I o o i

b. I o o I

c. i o o i

d. I o o I
i o o i

----25. (5pts) The offspring of the first crossed with pea plants of the same genotype. Which of the following describes the phenotype of the offspring of the second filial generation (F_2)?

a. 25% inflated pods, 75% constricted pods

b. 75% inflated pods, 25% constricted pods

a. 50% inflated pods, 50% constricted pods

a. 100% inflated pods

Questions 26, 27, 28, and 29 are about the following:

In squash a gene for white color (W) is dominant over its alleles for yellow color (w). Give the phenotypic percentage for the following results of each of the following crosses:

----26. (3pts) W/W x w/w.

a. 100% white

b. 100% yellow

c. 75% white, 25% yellow

d. 25% white, 75% yellow

----27. (3pts) W/w x w/w.

a. 50% white, 50% yellow

b. 75% white, 25% yellow

c. 100 % White

d. 100% yellow

----28. (3pts) W/w x W/w.

a. 100% white

b. 50% white, 50% yellow

c. 75% white, 25% yellow

d. 25% white, 75% yellow

----29. (5pts) In garden peas a gene for tall plants (T) is dominant over its allele for short plants (t). The gene for smooth peas (S) is dominant over its allele for wrinkled peas (s). Calculate the phenotypic ratio for the result of the following cross:

T t S s x T t S s

a. 9:3:3:1

b. 10:3:2:1

c. 12:2:1:1

d. 14:1:1

CURRICULUM VITAE

NAME	:	PEDRITO G. PADILLA
DATE OF BIRTH	:	July 17, 1955
PLACE OF BIRTH	:	Bacnotan, La Union
POSITION	:	Secondary School Teacher
STATION	:	Samar National School Catbalogan, Samar
CIVIL STATUS	:	Married

EDUCATIONAL BACKGROUND

Primary	Bacnotan Elementary School Bacnotan, La Union
Elementary	Bacnotan Elementary School Bacnotan, La Union
Secondary	North Provincial High School Bacnotan, La Union
College	Saint Louis University Baguio City
Curriculum Pursued. . .	Master of Arts in Education
Major	Administration and Supervision

CIVIL SERVICE ELIGIBILITY

As per provisions of P.D. 907 as amended by P.D. 993. March 19, 1978.

Career Service Prof. (E), June 17, 1979, 77.01%

Professional Board Examination for Teachers, (PBET) November 22, 1987, 83.20%

HONORS/AWARDS RECEIVED

Graduated elementary as Salutatorian

Graduated high school as Valedictorian

Graduated college as Cum Laude

Outstanding Teacher of Samar National School, awarded on Teachers' Day at Catbalogan, Samar on Dec. 13, 1989.

Outstanding Regional Trainor in Science and Technology II, awarded during the DECSRO VIII Day Celebration on June 22, 1990 held in Leyte National High School.

Regional Winner (Secondary Level), Dr. Juan Salcedo, Jr. Science Education Awards, July 22, 1993.

TRAININGS/SEMINARS AND WORKSHOPS ATTENDED

Institute for the Development of Educational Adminitrators held in Ateneo de Cagayan, Cagayan de Oro City, summers of 1984 and 1985.

Summer Science Institute (Biology) held in DWU, Tacloban, City, summer of 1983.

Colloquium on the Ministry of Teaching, Regional Health Training Center, Candahug, Palo Leyte, Oct. 7-9, 1983.

Seminar on Values Education, Samar National School, Catbalogan, Samar, Oct. 15-17, 1986.

Energy and Environmental Education, University of San Carlos, Cebu City, Oct. 21-24, 1982.

Higher Education Staff Development Program, Sacred Heart College, Catbalogan, Samar, Sept 22, 1983.

Research and Research Management, Samar National School, Catbalogan, Samar, Sept. 24-26, 1986.

Regional Youth Science Camp, Felipe Abrigo Memeorial School of Arts and Trade, Guiuan, Eastern Samar, Sept. 7-11, 1987.

Seminar-Workshop on the Enrichment of SEDP Instructional Materials, Tanauan, Leyte, Sept. 25-30, 1989.

Seminar-workshop on Module Writing, Tanauan, Leyte, April 5-7 1990.

DECS-UP Trainors' Training Program in Science and Technology II. UP in Diliman, Quezon City. May 2-27, 1980.

Values Development Orientation Seminar-Workshop, Cebu City, Oct. 9-3 1989.

Trainors' Attachment Program on JICA Equipment Training for Regions V and VIII UP-ISMED, Diliman, Quezon City, Aug. 5-7, 1992.

Seminar-workshop on the Implementation of Grants-In-Aid Program for R & D Projects/Programs in Science Education, Puntavilla, Arevalo, Iloilo City, Oct. 26-27, 1992.

Regional Seminar-Workshop on General Biology and Genetics, Universoty of Eastern Philippines, Catarman, Northern Samar, March 31- April 2, 1993.

Regional Seminar-Workshop on Ecology, UEP, Catarman, Northern Samar, Oct. 21-23, 1993.

LIST OF FIGURES AND TABLES