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What Beginner Biology Teacher Candidate know Genetics and Gene?

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Abstract
Misconceptions as barrier to understanding biology hence, to promote meaningful learning, it is necessary to overcome these difficulties with the heIp of different instructional methods rather than traditional instructional methods. Therefore it could be very intersting find out "how students prior knowledge genetic effect genetic knowledge of pupils during class education?"The preliminary investigations have been shown that usually the students have some difficulties in understanding the microscopic level genetic topics: such as the fertilization process and its products, the genetic variation, the mitotic cell cycle and the meiotic cell cycle. The findings of this study have been shown that students mostly have fragmented basic genetic knowledge at the beginning of teachinh process. They have basic understanding of DNA, genes and chromosomes, but lack detail. It could be intersting to work out if students' prioviously knowledge about genetics concepts education could effect their knowledge in genetics permanently.
Keywords: Gene education, DNA, misconception

1. Introduction

Genes, DNA, chromosomes, and related terms and concepts, have become familiar due to their occurrence in popular media. One of the misconceptions pertaining to genes is that they control every aspect of an organism's biology, including inheritance and behavioral patterns. However, those with an in-depth understanding of the subject of genetics would know about the different factors which play an important role in inheritance.

The living cell is one of the learning topics which appear in the junior-high science and technology syllabus, as part of the subject "organisms: phenomena, structures and processes". From the scientific point of view, understanding the main principle that a living cell is the structural and functional unit in all living organisms, is essential for understanding all the biological processes that take place in our world. Students mostly come to school with ideas about and explanation of the natural World and these ideas are as diverse as the students' backgrounds and they are often different from those of scientists.

These differing frameworks have been described as misconception that the characteristics of misconceptions are summarized by Adeniyi (1985). They tend to be stable, well embedded in individual', often resistant to traditional teaching methods. Misconceptions may originate from certain expcriences that same of them rooted in everyday experiences. However, from the pedagogical point of view reports on research which was conducted students pointed to difficulties in the comprehension of the living cell concept and its involvement in the processes of heredity. Genetics is considered to be one of the most difficult concepts in Biology (Oztas et al. 2003). The mechanisms are hard to understand because it is difficult to make the ideas be tangible without the help of special instruments (Mbajiorgu et al, 2006). The understanding comes from their formal education, the interpretation of the media, and from their own social experiences and observations (Venville et al, 2004). Students come to the classroom with their own conceptions of genetics from their own experience and observations.

The uses of the words, cell, chromosomes, DNA, genes, are interchanged in trying to explain how traits are passed from one generation to the next (Lewis and Kattmann, 2004). Students have an understanding on how genes play a role in transmitting traits, but this understanding is not aligned with the biological theory. The idea of heredity and DNA is drawn from what researchers call, "low culture sources" (Venville et al, 2004, 615). These sources were movies, comic books, television dramas, sitcoms, and science fiction. Media does not distinguish between genes and DNA. The words are interchangeable in situations and its mechanisms are not even considered during explanations.

There is a conception of genes not only determining traits, but also social and emotional bonds. The preconceptions also come from "everyday conceptual framework" (Lewis and Kattman,2004). Children create this framework from what they observe in their own families. Children's conception of genetics is based on the kinship of their families and relationships (Mbajiorgu et al, 2006). On the other hand, some other cultures do not use genetics at all to explain biological diseases, but they would rather make the connection with a belief system or an outside force.

The difficult thing about this misconception, and any other misconception, is reconciling it with a newer and correct conception of the topic (Lewis and Kattmann, 2004). The everyday struggle with misconceptions does not lie only with the students, but also with the teachers. Even if children use the science

jargon, they are not using the words properly. Students get lost in the science jargon and do not make any connections in between. Students do not fully grasp the mechanisms of inheritance. Genes are seen as small molecules that bear traits and are simply passed on from parent to child. Unfortunately it is not this simple. Students cannot connect how genes and DNA are related. It is not a tangible idea because it is something that they can easily observe with their own eyes. Students rely on being taught the mechanisms, but they get so lost in their own confusion.

It is often said, out of ignorance, that genes provide a blueprint of the functioning of the body. Analogy between genes and architectural blueprints is drawn, taking into account the properties shared by them on a superficial level. However, in reality, the one-dimensional model of genes (organized into a string of nucleotides) doesn't hold true.The flow of information originating from genes is not always a one-way flow. The chain of causality doesn't operate in isolation. In a biochemical system, different elements are entangled with each other. Therefore, it is difficult to single out a certain gene for a particular functionality. Finally, one should understand that there are many elements which act together in the smooth functioning of biochemical systems.

Genetics is a complex subject, and it is not surprising to find that there are many misconceptions about the different concepts of genetics. Although genes determine most of the characteristics in a living being, there are many other factors which come into play in determining its behavioral traits and patterns.It is important to know students' misconceptions, presuppositions, and prior knowledge in Genetics. Teachers have a difficult time changing and teaching ideas, while students have a hard time understanding and connecting these ideas because Genetics is taught at the macro,

micro, and symbolic level (Mbajiorgu et al, 2006). Teachers must be aware of this because it allows insight into the observations that students have already made. This can be used as a starting off point in trying to re-conceptualize their ideas. The conceptions mentioned before prove that students do not holistically understand Genetics. Teachers can help better connect the ideas that students already have about genes, DNA, and inheritance with the bigger picture on Misconceptions 4 the micro, macro, and symbolic level. If teachers are not aware of these misconceptions, it creates barriers that lead to confusion and incoherence (Lewis and Kattmann, 2004).

Not only should the teachers be aware of these misconceptions, but also the students. When students recognize these ideas, being able to change or enhance them will be easier. Students might be able to make the connections themselves. Being able to discuss their ideas can help breakdown what is wrong and right about the misconceptions. The students can actively construct and reconstruct their knowledge with the discussions. Teachers need to accept that these presuppositions are present and they need to use it towards their advantage. The prior knowledge of the students do have a basis, it just needs to be clarified.

Teachers should not be discouraged in teaching genetics, but rather use the prior knowledge of their students. It is important because students need to be able to understand the basics of Genetics in order to be literate in growing technology of science. Genes are not just this cultural idea, but a powerful scientific idea. Students will need to be science literate citizens so that they may understand their health in the present and in the future. (Venville et al, 2004).

It could be intersting to work out if students' prioviously knowledge about genetics concepts education could effect their knowledge in genetics permanently. Before teaching the genetics and biotechnology concepts a pretest previously prepared by Levis & Katmann, 2004) modified for his study given to students. This pretest was designed to asses students knowledge of basic genetic concepts and determine if they held any alternate conceptions.

Recent advances in genetics affect many aspects of life. For instance, Human Genome Project, animal and plant cloning, DNA fingerprinting, stem cells and genetically modified organisms are become reality of our daily life. It is possible to claim that in order to understand the basic life science concept such as IVF, cloning, DNA fingerpirnting and others basic genetic knowledge are necessary. In this point for this study work out what students already know about basic genetics and biotechnology may help shape genetic lessons for better education. For this students' answer to each question may help developing better teaching strategies. The replying all parts of each question may allow applying a suitable education during teaching period.

2. Material & Methods

A questionnaire, previousl prepared by Wood-Robinson, (2000) and Levis & Katmann (2004) and modified for his study were administered to the first year biyology education students (Biology teacher candidates). The questionnare (Table I) has been covered totally heredity concept. The activities attempted to overcome some of the comprehension difficulties and misconceptions about heredity and attempted to assimilate students the scientific knowledge about heredity and gene concepts. For this, students graded on how thoroughly they answer each question, not the accuracy of their answers. Our are interested in learning what students already know about genetics and biotechnology to help shape our lessons for this unit. For these it has been stated that students should take their time to answer all parts of each question. This will allow students to receive full credit for each

answer.

1.The six biological items in the list below are all parts of living systems. Please write the ones you have heard of in the spaces provided below from largest to smallest.

Cell, Chromosome, Gene, DNA, Organism, Nucleus

Largest: _____
_____
_____
_____
_____

Smallest: _____

3. Now I would like to know how much you know about each of the following terms:

Genes: ____ I have never heard of genes.
____ I have heard of genes, but don't know what they are.
____ I have heard of genes and could say something about them.

a. Where in your body are genes found? _____

b. What are genes made up of?

_____

c. Why are genes important?

_____

DNA: ____ I have never heard of DNA.
____ I have heard of DNA, but don't really know what DNA is.
____ I have heard of DNA, and could say something about it.

a. Where in your body is DNA found?

_____

b. What is DNA made up of?

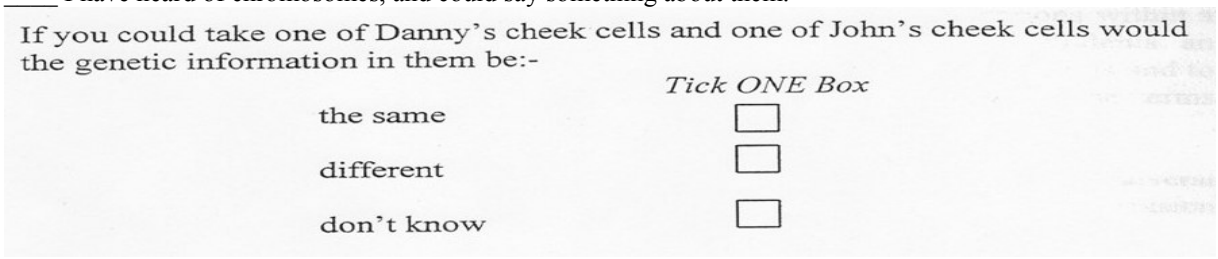
_____

c. Why is DNA important?

_____

Chromosomes:

____ I have never heard of chromosomes.
____ I have heard of chromosomes, but don't really know what they are.
____ I have heard of chromosomes, and could say something about them.


If you could take one of Danny's cheek cells and one of John's cheek cells would the genetic information in them be:-

Tick ONE Box

the same ☐

different ☐

don't know ☐

Part 2

This part of the question asks you to make comparisons between the cells from two different people - Danny and John.

Danny's cheek cell

John's cheek cell

If you could take one of Danny's cheek cells and one of John's cheek cells would the genetic information in them be:-

Tick ONE Box

the same ☐

different ☐

don't know ☐

Reasons:.....

.....

.....

'Cell Division'

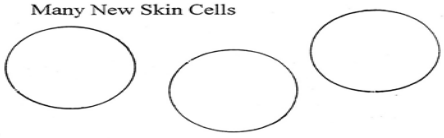
This question is in two parts.
Part 1 asks about cell division for growth and repair.
Part 2 asks about cell division for the production of sex cells.

Part 1

In animals, skin cells divide again and again to produce many new skin cells.
In the diagram below some chromosomes have been drawn into the original cell.

Original Skin Cell

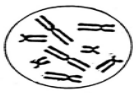
Many New Skin Cells



If the original skin cell contained the chromosomes shown in the diagram above, what chromosomes do you think the new skin cells would contain?

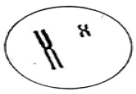
Look at the diagrams below and tick ONE box to show which chromosomes you think would be found in the NEW SKIN CELLS.
Please give reasons for your answer.

Tick ONE Box



_____ ☐

_____ ☐



_____ ☐

Don't Know _____ ☐

Reason:.....

.....

.....

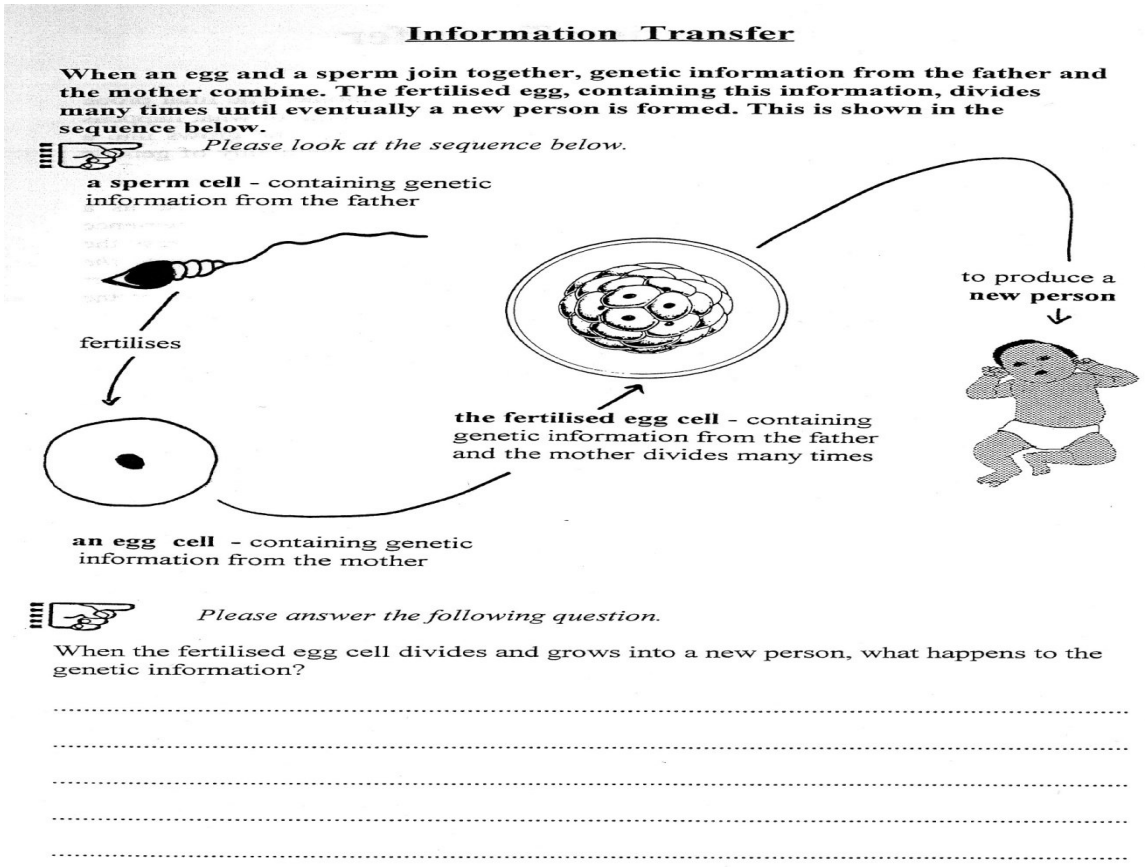


Table I. A modified questionnaire applied to students which previously prepared by Wood-Robinson, (2000) and Levis & Katmann (2004.

3. **Findıngs**

The results of students survey has been shown in Table II & III. The correct and wrong answers shown in the Table II separately. ***In group I,*** 5 students had sequenced given part of living systems' according to their sizes as organism-cell-nucleus-chromozom-gen-DNA. Other 3 students made an arrangement as Organism-cell-nucleus-DNA-chromozom-gen. The rest of students (12) made an arrangement correctly such as Organism-Cell-nucleus-chromozom-DNA-gen.

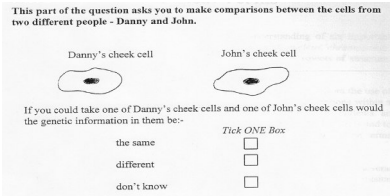
1.A list below given parts of living systems. Please write below from largest to smallest *(Cell, chromosom, gen, DNA, Organism, nucleus)*		*Correct answers*	*Wrong answers*	*I don't know*
	Group I	*12*	*9*	*0*
	Group 2	*06*	*10*	*0*

Table II. 36 (Group 1:19; Group 2:16) students completed the survey

In group 2. The second group of students were completed cell biology and genetic courses students and additional courses such as moleculer cell biology in the sama department. Just before graduation the questionnare has been applied them.

According to findgs totally 16 students replied the questionnare and there was no any answer such as "i don't know". The results have been shown that 6 of students managed arrange living cells part according to their sizes. But the answers of 10 of them were not correct. For example, 5 of them given part of living things squenced such as Organism-cell-nucleus-DNA-chromozom-gen.

An other student sequenced Organism-cell-gen-chromozom-nucleus-DNA.Oneof them sequenced like Nucleus-chromozom-gen-DNA-Organism-cell, it was totaly wrong. Similar answers was available also such as Organism-cell—nucleus-DNA-gen-chromozom. Organ-DNA-chromozom-gen-cell-nucles, Organ-cell-DNA-chromozom-gen-nucleus were other wrongly designated according to their sizes.No statistical significance to the results, some answers definitely attributed to students misinterpreting questions. Students mostly attributed cheek cells being identical to being from the same part of the same person. More students in both groups understood that cells from different people had different genetic information. Students who had studied genetics ***(Group 2)*** tended to give more scientifically detailed explanations. Some students in both group based responses to on appearance of illustrations.

1.a. How much you know about each of the following terms:	**Group I**	**Group II**
I have never heard of genes. I have heard of genes, but don't know what they are. I have heard of genes and could say something about them. No answer	1 1 16 1	0 1 15 -
2.b. Where in your body are genes found?	Except germinative cells, all body cells…… ……(4) Nucleus…… (2) Chromosoms…… (5) DNA…. ……..(3) Germinative cells…… ……(4) I don't know ……..(2)	All body ells…….....(5) Germinative cells ……(1) Expect some cells, nucleus & mitochodria……(1) Chromosoms……..(1) DNA……(8)
2.c. What are genes made up of?	Protins……(3) Heredity Materials……(4) Base,sugar &phosphat……(2) DNA……(3) Nucleotidler&proteins……(1) Chromosoms……..(1) No answer……..(6)	Bases…… (2) Nucleid asids……...(4) DNA……(1) Heredity materials……...(1) Nitrat compouds……..(2) Three amino acids……(1) Nucleotids, chromosom,nucleus ...(1) Purin, Purimidin, 5C sugar, deoksiriboz……..(1)
2.d. Why are genes important?	Because it contains heredity material ……..(14) It is necessary for matabolic activity(3) No commet…… ……(2)	It Because it contains heredity material……...(13) It is necessary for matabolic activity……..(1) It is important for genetic varieties……..(2)
I have never heard of DNA. I have heard of DNA, but don't really know what DNA is. I have heard of DNA, and could say something about it.	0 0 20	0 0 16
b.Where in your body is DNA found?	All cells ……..……(13) Mitochondrion……(1) Nucleus & cytoplasm…… ……(1) Nucleus……(1) Chromosom……..(1) No comment……..(2)	All cell……..(04) Nucleus…… ……(05) Nucleus &mitochondion……(05) In compounds of organs……(1) All cells & some organells (?)…...(1)
a. What is DNA made up of?	Bases+Sugars+phosphates…….(12) Nucleotids……(1) Genes+nucleotides+chromosomes..(1) Bases+sugars……...(1) Bases+nucleid asids……(1) Bases……..(1)	Nucleic acids……(10) Nucleic acids+proteins……(1) Bases……(2) Bases+sugar……..(1) Genes……...(1)
e.Why is DNA important?	DNA is heredity material…… (14) For metabolic activities…….(1) For genetic varieties…… (3) It is important for cell reproduction & cell division……..(1)	DNA is heredity material…..... (16)
I have never heard of chromosomes. I have heard of chromosomes, but don't really know what they are. I have heard of chromosomes, and could say something about them. I have no idea	**0** **0** **16** **3**	**0** **2** **14** **0**
6.  	the same……..(02) diffrent……(17) I don't know……(0) Why same;Because these cells are identical for all people.They have the sama appearence. Why diffrent:They have diffrent moms & dads, so they genetically diffrent each others.	the same…….. (01) diffrent……..(14) I don't know……(01) Why same; Because these cells have the sama genetical structures. Why diffrent:Each cell identifal for only that people.

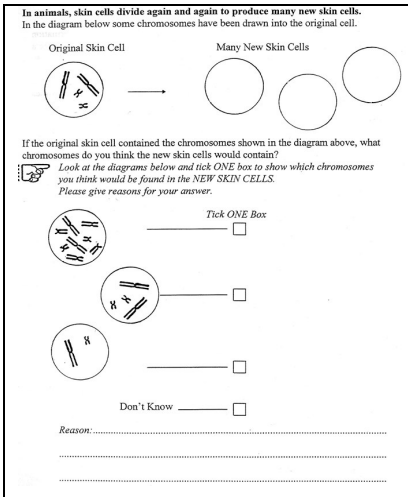
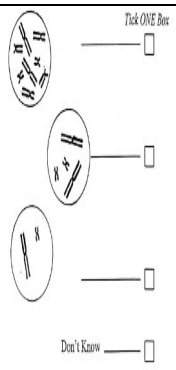
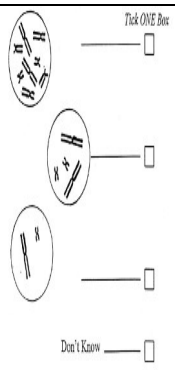
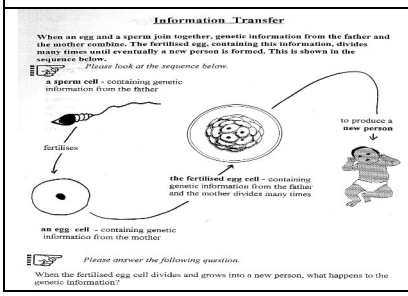
	 Correct…… (16) Wrong……..(2) For correct answers why: Because the cell have had mitos division. After mitos division in each cell chromosom numbers same as parent cell….. Why wrong; no comment…	 Correct…… (13) Wrong……..(03) For correct answers why: Because the cell have had mitos division. After mitos division in each cell chromosom numbers same as parent **cell…..** **Why wrong;**After mitosis chromosomes numbers reduced into half..
	The genetic information form mom & dad pass through the child……(11) No any comment……(08)	The genetic information form mom & dad pass through the child….(10) Genetic information going chang.(1) No any comment……(08)

Table III. The answer of of pupils for " the gene" concept

No significant difference between the two groups in whether or not they had heard of cells, chromosomes, genes, DNA, organism & nucleus could accurately sort from largest to smallest, in Group 1, and Group 2.

Many students in both groups were able to describe that the genetic information multiplied within the new baby. None specified that the genetic information in all of the baby's cells was identical. There was no statistical differences between two (Goup 1 & 2). There was not any alternate conceptions affected learning. Possibility students misreported having studied genetics or not.

It has been shown that some student knows the structures and functions of nucleic acids in the mechanisms of genetics. The student is expected to: compare genetic variations observed in plants and animals. The comparing the processes of mitosis and meiosis and their significance to sexual and asexual reproduction. The sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations from the offspring of any two parents."

4.Discussion

The findings of this study have been shown that students mostly have fragmented basic knowledge about heredity and the function of genes. They have basic understanding of DNA, genes and chromosomes, but lack detail. Some of them understand that genes are "everywhere," "all over" and "in chromosomes".

It is well known that genes are made up "when parents come together" and genes are important because "it tells you what you got from what parent". Alternate conceptions demonstrated genes are found "in your DNA". Each concept in biology is closely related to others (Novak, 2010) and certain prerequisite concepts are necessary for a learner to develop understandingon a certain concept. If these do not exit, it would be difficult for the learner to understand the new concept. When failing to grasp the basic concept, they tend to employ a rote learning strategy in studying biology in order to pass examination in biology.

Misconceptions as barrier to understanding biology hence, to promote meaningfullearning, it is necessary to overcome these difficulties with the heIp of different instructional methods rather than traditional instructional methods.

The results of the preliminary investigation showed that the students have difficulties in understanding the microscopic level topics: such as the fertilization process and its products, the genetic variation, the mitotic cell cycle and the meiotic cell cycle. It was found that the learning activity reduced to some extent students'

misconceptions and increased understanding of the microscopic level among students. Similar difficulties also detected in our study. The ratio of noncorrect answers students replied may reflect this result.

It is well known thattThe concepts of inheritance and variations in living beings are covered under the study of genetics. It is a bit complex and difficult to understand, and the complexity gives rise to a number of misconceptions. Scientific concepts can be understood correctly only if they are explained to students in an easy-to-understand manner. In case of a complex subject like genetics, this becomes even more important. Explaining the concepts, taking into account the minutest details becomes necessary. They can be understood on a macro, micro, and symbolic level. A correct or rather complete understanding cannot be obtained only from either of these levels.

The students often fully understood the variety that exists in human genetics, knowing that each person is unique but did not recognize that genetic variety is evident in all living things. Furthermore, students had difficulty interpreting the probability with the genotypic and phenotypic ratios associated with genetic crosses (Lewis J, Wood-Robinson C., 2000, Oztas et al., 2013). The influence of the genetic variation focused on the chromosomal level and on the differences between chromosomes. In addition, the learning activity helped to make connections between students' prior knowledge and the new knowledge which is presented in the activity. Therefore, the newly developed learning activity may lead to a better understanding of the topic even after a long period of time. In addition, it was noted that the learning activity encouraged the acquisition of thinking and learning skills, inquiry and problem solving skills and also contributed to the students' pleasure from the learning process.

A gene is formed of alleles. The term dominant allele is mistaken for the allele found in great number in nature. Those who don't have a correct understanding of the concept of dominant allele jump to the conclusion that dominant alleles are of common occurrence in nature. For a gene to be found in greater proportion in nature, there needs to be more copies of it. It is as simple as that. The concept of dominant allele has nothing to do with the number of genes or their One of the misconceptions about genetics is that a single gene (set of alleles) determines a single trait/attribute.

A deeper understanding would reveal that this assumption does not hold true for all genes or traits. For example, eye color is determined by at least 3 genes. As per recent, the color of the skin is determined by about 100 genes.A phenotypic expression cannot always be attributed to only a single gene. Therefore, a particular trait or attribute can be determined by more than one gene. Also, many other factors, including environmental, are responsible for the phenotypic expression of a trait.

The concepts of inheritance and variations in living beings are covered under the study of genetics. It is a bit complex and difficult to understand, and the complexity gives rise to a number of misconceptions. Scientific concepts can be understood correctly only if they are explained to students in an *easy-to-understand manner (Levis et al., Oztas et al., 2003). In case of a complex subject like genetics, this becomes even more important. Explaining the concepts, taking into account the minutest details becomes necessary. They can be understood on a macro, micro, and symbolic level. A correct or rather complete understanding cannot be obtained only from either of these levels. Misconceptions arise from an incorrect understanding of a concept or phenomenon. Therefore, it becomes necessary to verify the information before you accept it as a fact and to know how students comment the basic knowledge of heredity and gene just before biology education. The educator of biology should be notice that it is difficult to unlearn a particular concept, once you believe it as true.*

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