Module DNA, Diversity and Heredity

Presentation

This module is part of the Imagine Project coordinated by the Federal University of Santa Catarina. It is a project of international solidarity that aims at the scientific inclusion and the cultural interchange among peoples. It seeks to open a discussion about the diversity and variability amongst living beings, with their similarities and differences, as well as between human beings, who are naturally diverse both "within" and "between" different peoples and ethnicities.

The understanding of this highly complex subject demands a set of activities and discussions with the groups involved, ranging from debates to presentation of videos, explanatory classes, practical lessons and diversified experiences that culminate with the molecular study of DNA and its implications on diversity and heredity.

Yet, in order to reach this microscopic and molecular universe, a strategy has been established that goes from the macroscopic observation to an interpretation of the molecular universe.

The concepts of diversity and variability can be approached by means of gathering and classification of sample materials such as parts of plants, animals, etc. After close observation of the collected material, practices are proposed, like the ones that involve identification of similarities and differences, taking into consideration the establishment of criteria to form groups. Deriving from this approach, it is possible to advance the discussions on the observation and interpretation of human types, by means of criteria that allow us to join them in varied and flexible subgroups.

It is important to note that these established criteria often depend on the measurement of individuals; therefore, measures taken with various instruments are important tools to be explored. These types of activities intend to demonstrate to the participants that any type of classification is subjective.

However, not all characteristics that can be possibly used as criteria to form groups are available for observation with the naked eye, since our universe ranges from the macro to the microscopic. More elaborated practices can help in the assessment of these characteristics, as the chromatography on paper or even the extraction of DNA from different species (visible to the naked eye like a cluster of molecules).

It is important to remember that even by observing DNA molecule clusters, it is not possible to readily understand the processes that rule the production of molecules, which, through multiple interactions, participate in the constitution of the characteristics of all living beings. Simple practices using assembly parts can help us with the understanding of how such mechanisms work. Moreover, these practices stimulate discussions about the genetic code, concerning its organization and the way the cells decode it.

Finally, activities using more complex techniques, which demand specific technological support, allow the identification of the genetic material with a higher level of details, also allowing comparisons within and between different species.

Gathering and Classification of Materials

Overall Goals

To comprehend systems of classification.

Specific Goals

1)To discuss the concept of criterion.

2)To establish criteria for classification and to apply them to the materials obtained by means of gathering.

3) To conclude that classification criteria are subjective.

Procedures

1) Collecting the material.

• Establish two or three locations, in different environments nearby the community where the participants live, work or study, to be used as points of gathering of biological material and/or non-biological items (for example, leaves, flowers, fruits, stones, garbage etc.).

• Divide the participants in 3 or 4 groups;

• Each group must collect 5 to 10 different unities of the previously determined items.

The number of items will depend on the quantity of arranged groups, for example, for 4 groups, collect: 1)stones, 2)leaves, 3)flowers, 4)garbage.

• Ask each group to go to one of the determined places for gathering;

• The suggestion is 15 to 30 minutes of duration for the gathering.

Expanding the discussion!

At this moment you can ask the participants to describe the environment of the gathering with the purpose of discussing about the native and exotic species, anthropic action, climatic conditions, the terrain etc.

2) Classifying the collected material:

- **Put together, on an appropriate surface (ex.: a table or a bench), the collected materials, grouping them by item. For example, put together all the leaves collected by the different groups in a single set, according to the figure 1.**

Figure 1: Items not separated by classification criterion

- Discuss the concept of criterion and ask participants to give examples (considering the existence of a later specific activity using human groups, the suggestion is to not use examples involvinghuman characteristics at this moment).
- Define only one item (Ex.: leaves for group 1 and flowers for group 2 etc.) to be initially worked in each group.
- Ask the groups to organize their items according to different criteria defined and described by themselves (see examples in figure 2). Take note of the chosen criteria.

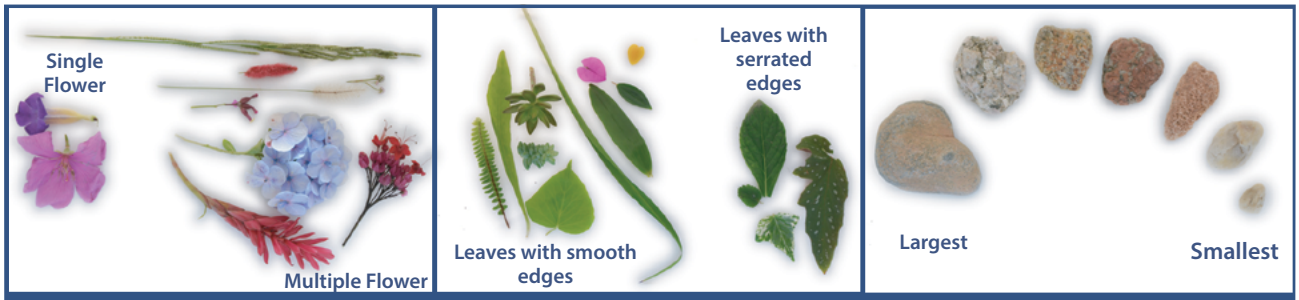


Figure 2: Items separated by classification criterion

SUGGESTION: For a more interesting discussion, it is important that participants do not receive tips about the possible criteria, but it is important that they are encouraged to establish them themselves, choosing as many criteria as possible.

- If possible, photograph the groupings constructed by the participants for later presentations using multimedia equipment.
- Ask the groups to choose one of the produced patterns to challenge another group to find out which criterion was used.
- Exchange the groups, in a rotating basis, to redefine the classification according to new criteria. Each group will go through all the collected items, writing down all their criteria. If possible, photograph the results.

3)Discussing the importance of classification

- **Discuss the results about the different arrangements made by the groups, if possible, with pictures shown with a projector.**
- **Highlight the unlimited number of possible combinations in function of different criteria.**
- **Discuss the importance of classifying, especially in the biological context;**
- **Conclude the discussion, highlighting the subjectivity of the criteria for classification, as different perspectives on a single set of items can lead to distinct group arrangements.**

The Human Types: Culture and Geography

Overall Goals

To critically discuss the concept of human races.

Specific Goals

1) To identify the human types, correlating their physical characteristics and their clothes to their supposed geographical origins.

2) To perceive how the observer culture can influence in the classification of human types.

3) To conclude that the criteria for the classification of human types are flexible and subjective.

Necessary Materials

- World Map (appendix);

We suggest the projection of the Map through a multimedia projector and fixing the cards with the different human types directly onto the screen or the wall.

- Twelve cards with the human types (appendix);

Print a sufficient number of colored copies considering the number of group members. For a better conservation of the cards, it is suggested that this material gets plasticized.

- Template for applicators (appendix);

1) Classifying the participants:

- AClassifying the participants: - Ask the group to establish criteria for the classification of the participants (i.e. sex; type of clothes; height; other characteristics that can be externally observed; or even those that are not explicit but allow a separation into distinct groups, like ancestry, place of birth, age etc.). It is important that the participants choose the criteria.
- Ask the participants to propose the reorganization of the groups according to other criteria.
- Observe and comment that people can be placed together according to one criterion but set apart according to another, when the parameter of similitude is changed.
- Furthermore, discuss that the criteria depend on the consensus among the participants, once characteristics such as age or height, for example, are subject to the definition of limits between one range and another.

Expanding the discussion!

Expanding the discussion! It is important to realize that this discussion can advance with the request to reorganize the subgroups through the introduction of a new criterion. For example, if the chosen criterion is about the color of the clothes (dark or light), the groups can be separated using more specific colors, generating new subdivisions.

2)Geographically locating the human types

- Separate the participants in two or more groups.
- Give them the images of human types. Select the convenient number of types according to the availability of time for the activity execution (for example, five, six, ten etc.)
- Give an identical set of selected cards for each group, along a copy of the world map in A4 paper to be used as a template of the distribution.
- From the analysis of possible characteristics to be observed in the images, the groups must determine and mark on the paper map which region is supposed to be the origin for each one of them.

Expanding the discussion!

At this moment, you can stimulate the groups to search for (in an atlas, globe or on the internet) the real location of the chosen countries, taking advantage of the activity to work the Geography as a transversal subject.

- Separate the participants into two or more groups.
- Give them the images of the human types. Select a sufficient number of types (for example, five, six, ten etc.) according to the availability of time for the activity.
- Give an identical set of selected cards for each group, along with a copy of the world map in A4 paper to be used as a template of the distribution.
- From the analysis of possible characteristics to be observed in the images, the groups must determine and mark on the paper map which region is supposed to be the origin for each one of the human types.

Attention!

In this case, the goal must not be to establish the right or wrong, but to show that, throughout time, more and more people occupy distinct regions of the world, motivated by different interests of migratory flows.

Expanding the discussion!

At this moment, you can stimulate the groups to discuss historical, cultural, economic and political aspects that lead to these migratory flows.

Measuring With Instruments

Overall Goals

To measure biological material by using various instruments and allowing the perception of the usefulness of precise measures.

Specific Goals

1) To recognize and value the day-by-day, regional and/or official ways of measuring.

2) To learn how to use diverse instruments for measuring: length, area and weight.

3) To compare measures taken with and without instruments.

4) To establish relations between the macro and microscopic levels.

Necessary Materials

- **Plant leaves of similar size and shape (our unities per group);**
- **10 or 15 cm rulers (one unit per group) (if possible, also use the ruler with the inches scale);**
- **Graph paper;**
- **Pachymeter (if possible);**
- **Balance (if possible);**

Observation: The use of leaves is suggested to this practice because they are a biological material easy to obtain in most part of the rural zones. In desert regions, however, seeds, bones or even stones can be used.

1) Observing the biological material

- **Form subgroups of four or five participants.**
- **Provide measuring instruments (ruler, pachymeter and/or balance) and ask the participants to measure the four leaves in order to answer the following question: What is the measure of the leaf?**

Observation: At this moment, doubts will come up about which measure should be taken - length or width, total area, weight – or whether the group should measure one or four leaves. The necessity of establishing one criterion will possibly come up naturally amongst the participants.

2) Optional Introductory Activity

- Project a figure with four leaves, for all the groups, and ask them to, individually, describe the material

Then, give to each group a magnifying glass and ask them to write down their observations. The idea is to realize that, by refining the instrument of analysis, they can see things that could not be seen before, for example, pores, hair, details of the ribs or the serrated edges (or even seeing that what had been classified as a smooth edge can present a serrated pattern when observed like that).

Discuss that each description is subjective, in other words, each one has the look of the person who describes it and depends on the instrument used.

3) Discussing the importance of precise measurements

- Discuss the results with each group, realizing that each leaf has its own measure, but they needed to inform one unique and representative value to the large group.

- Calculate the average between the measured values and ask one student of each group to tell their results to the big group.

- Discuss the reasons that may have led to the different values (raising hypotheses) between the groups.

Suggestion: If possible, take a picture of the leaves that will be given to each group. Each group should receive a group of four leaves of similar shape, color and "age" (for example, one group of new leaves, other of larger and older leaves, another one of recently fallen leaves and another of dry leaves). When the activity is made in this way, it can stimulate the proposal of hypotheses and a discussion about them.

The DNA Seen by the Naked Eye

Overall Goal

To obtain and visualize the vegetable DNA through a simple protocol.

Specific Goals

1) To make a transition between what is visible what is invisible to the naked eye.

2) To introduce the participants to molecular biology.

3) To demonstrate that it is possible to extract the genetic material from living beings.

Necessary Materials

- 1 Plastic bag, preferentially with a closing system (e.g. ziplock).
- 3 Strawberries (or, with the necessary adaptations, it is possible to use other plants, such as banana, kiwi, onion, tomato etc.).
- 1 Kitchen sieve.
- 15mL of cold common ethyl alcohol
- 1 Test tube of 25 mL
- 1 Beaker of 500 mL
- 1 Glass of 200 mL
- Colorless kitchen detergent
- Common salt
- 1 Glass rod
- 1 Pair of latex gloves per person
- 1 Teaspoon
- 1 Tablespoon

Preferably, the participants will wear lab coats that can be disposable.

Procedures

1) Discussing the DNA

- Discuss with the participants the concept of inheritance of traits in plants, animals and human beings. Ask them to describe how the heredity is seen and interpreted in their culture and what they know about the genetic material. If they don't mention the term DNA, lead the discussion so it gets there.

Expanding the discussion!

At this moment, you can ask the participants to give examples of biological inheritance in the agriculture practiced in their region and to explain how the local farmers understand and take advantage of this heredity.

2) Preparing the plant issue for the extraction

Divide the participants in four or five groups.

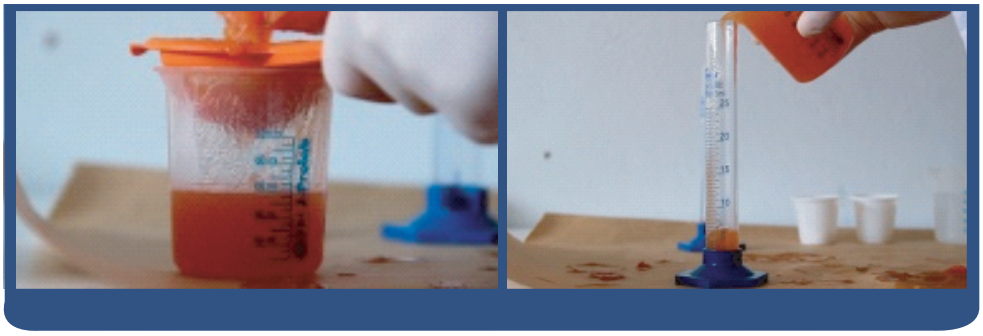
- Two or three people in the group will be in charge of preparing the extraction solution: In a glass, mix 150 mL of water, a tablespoon of detergent and a teaspoon of salt, stir with the glass rod trying not to foam.
- Select the strawberries and put away the leaves. Put the strawberries in a bag and ask the other group members to macerate them with their hands, crushing them until it becomes a paste.

3) Extracting the DNA

- Add approximately 1/3 of the extraction solution (50 mL) into the bag that contains the strawberry paste and leave it for thirty minutes. Turn the bag over once in a while trying not to foam.

Suggestion of activity: At this moment, while they wait, you can ask the participants to try to guess which color the strawberry DNA will be. Do all the organisms have the same DNA?

- With the assistance of a sieve, filter all the contents of the bag into a beaker, leaving the pulp away.



- Transfer about 10 mL of the filtered liquid to a 25 mL test tube.

Suggestion: At this moment, let the participants know that they are about to see the DNA inside the test tube. They should pay close attention to observe what is going to happen in the next step, because its appearance changes very quickly.

- Add the cold alcohol until it completes 20-25 mL. Without stirring it, wait for a few minutes until the DNA gradually appears in the shape of a cloud and condenses itself in the shape of a viscous material.
- Try to "hook" the DNA with the assistance of the glass rod.

- Discuss the results in relation to the expectations. Talk about what represents that DNA lump. Ask if we could eat that material and what would happen if we did it.
- Comment to the teacher: the method used also extracts other similar molecules, like different types of RNA.

The Universe of the Microliters

Overall Goal

To comprehend and manipulate tiny volumes of liquid in lab situations.

Specific Goals

1) To discuss the different units used in the measuring system.

2) To introduce the participants to the universe of the microliters.

3) To learn how to use automatic micropipettes in an accurate and safe way.

Necessary materials

- **Automatic micropipettes of various shapes and capacities (i.e. P10, P100 e P1000).**
- **Disposable tips in sizes compatible to the pipettes.**
- **Beaker with water or colored liquid.**
- **Plastic tubes (i.e. 1,5 mL microtubes).**
- **Recipient for disposal.**

We present, in this screenplay, a suggestion of materials that can be replaced or adapted. Micropipettes, tips and old/used tubes can be borrowed from clinical analysis labs or partner universities.

Procedures

1) Discussing the measuring units

- Discuss the main physical quantities and their units, like length, mass and volume, asking the participants how they measure these things and which name and symbols they are used to use. Ask for examples of volume measures used in the context of the local community (i.e. liters of milk, fuel or water).

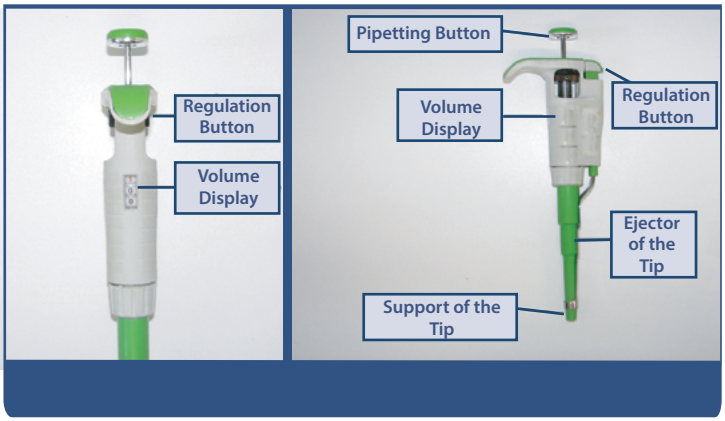
2) Transposing the discussion to tiny volumes

- Ask the participants to suggest ways to collect, to measure and to transfer smaller and smaller volumes, , until it gets to the microliters.

3) Presenting the micropipette and its tips

- Choose a pipette with a range of volumes between 200 to 1000 µL (depending on the available pipettes) and present its parts.

- Show the display and the adjustment button with the measuring scale, explaining the meaning of the digits.

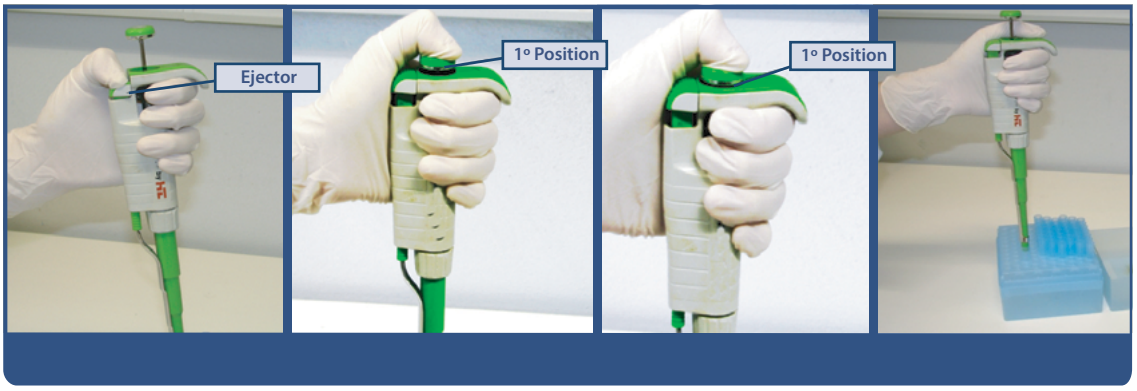


- Demonstrate that the pipette presents two stages of resistance:

First stage will be used to suck the liquid to the tip;

Second stage will be used to expel the liquid that is on the tip;

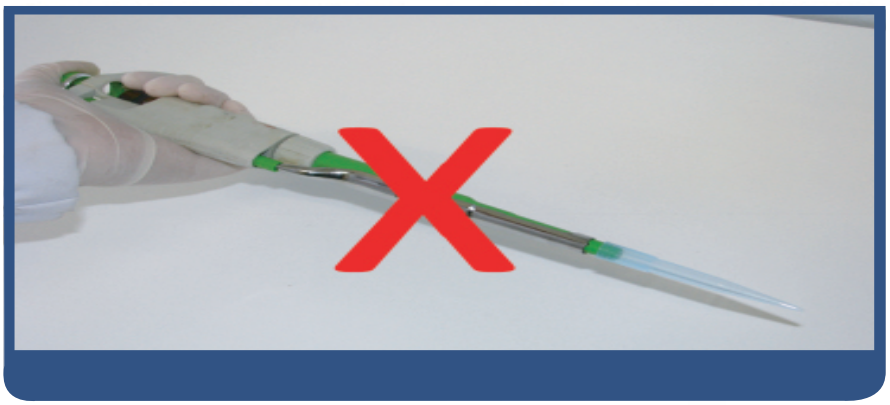
- Demonstrate how to put a tip in the pipette. Pipet, drawing the liquid from the first position and dispensing it into another recipient, pressing the button up to the second position.



- After the completion of pipetting, discard the tip pressing the correspondent button.

Emphasize the right way of handling it:

A: The pipette can never be held in a horizontal way, avoiding contamination;



B: Never exceed the maximum or minimum volumes of the pipette.

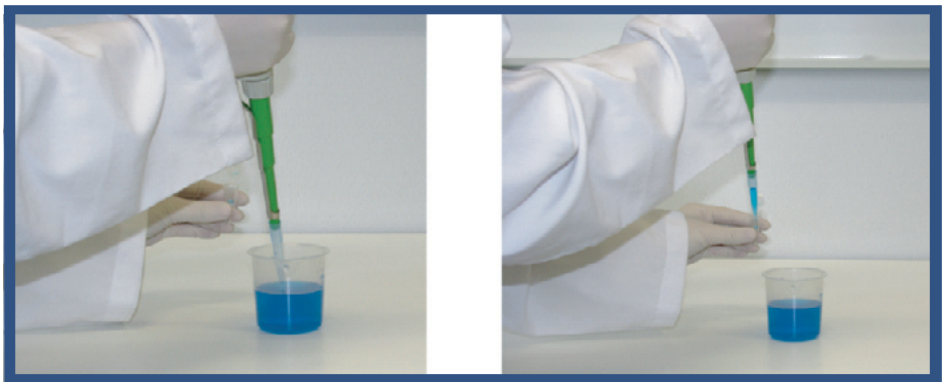
C: Gently press and release the pipetting button.

D: Change the tip for each different sample to avoid the contamination of the fix part of the pipette with the used liquids.

4) Practicing with the participants

- Practicing with the participants - Write on a board the volumes to be pipetted by each participant, preferably using all the available pipettes in the form of rotation.

- Ask the participants to pipette the the correspondent volume of liquid (water) from the beaker and dispense it in a plastic tube.



Check if all the participants are regulating and pipetting correctly.

- If there is an available P10 pipette, ask one participant to pipette the volume closest to the minimum and dispense it in the palm of the hand to show how tiny that quantity is.

- Explain that when people work with liquids, in order to avoid any type of risk for those who manipulate them (i.e. samples of DNA, reagents, diverse products) as well as to avoid contamination, it is necessary to work with disposable gloves, lab coat and, in special cases, glasses and masks. Check if all the participants are regulating and pipetting correctly.

Deciphering the Code

Overall Goal

To comprehend the way codes, in general, are deciphered.

Specific Goals

1)To work with different combinations that represent codes starting from isolated units.

2)To establish relations between constructed sequences and a given code.

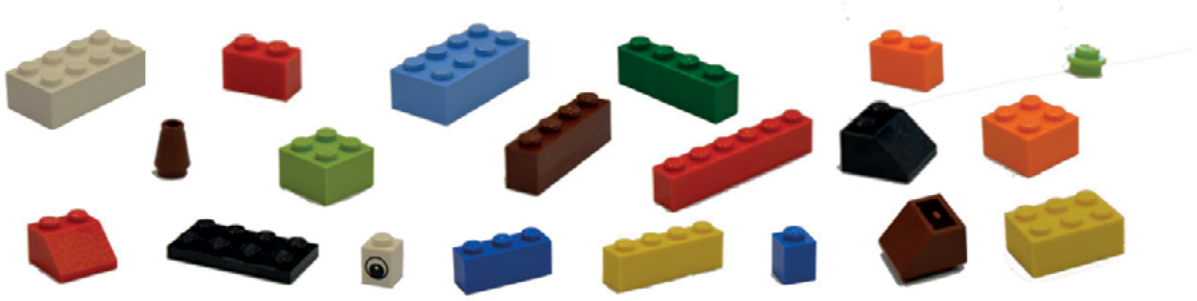
3)To work with the concepts of variants and redundancy of codes.

Necessary materials

- Square pieces of Lego©, in the colors red, yellow, white and blue. It is suggested to use 30 to 40 units of each color.

- A table with the different combinations of three colors and the pieces thatthey determine (see Annex 1).

- 20 pieces of Lego© of different shapes and/or colors, in ideal quantities of 10 units for the least frequent types and 20 to 30 for the most frequent ones, in function of the combinations presented in the table.



We present, in this script, a suggestion of types and colors of pieces of Lego©. Observe that, depending on the availability of pieces you have, it will be necessary to make changes. Be careful, when making changes between pieces of colors or shapes that are different from the ones suggested here, to keep the correct relations in correspondence with the ones presented in Annex 1.

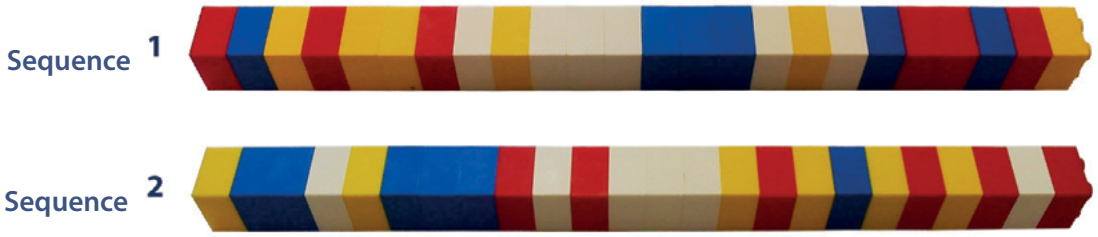
Discussing different codes

-Discuss with the participants the concept of codes, asking them to mention different examples (numbers associated to dates and phone codes; letters associated to words in different languages that use the same alphabet; other alphabets; sign languages; etc.)

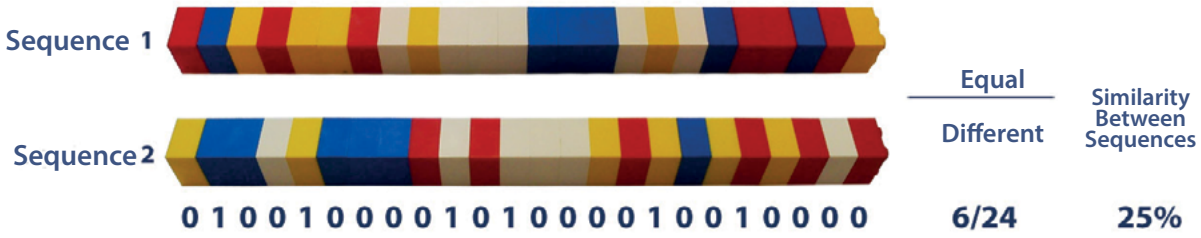
- Make groups with 8 to 10 participants (this number can be smaller or larger in function of the size of each classroom and the number of available Lego pieces).

- Distribute six square pieces of Lego of each color.

- Ask each group to build a sequence, chaining the 24 pieces, randomly.

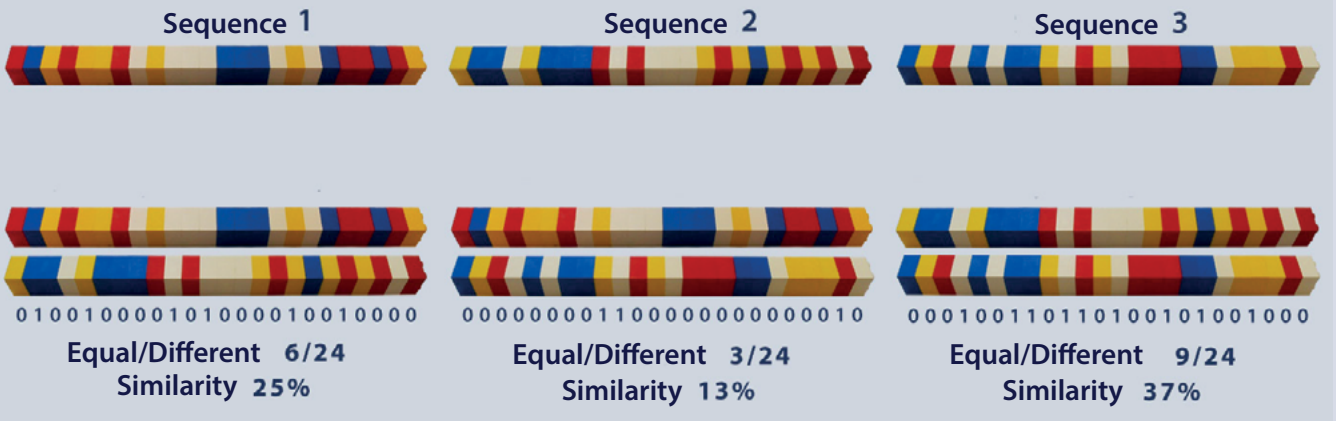


- Ask the groups to put their sequences, two by two, in a parallel way and to compare them in function of the quantity of equal (1) or different (0) pieces in the same position, calculating afterwards the percentage of similarity between them.



Expanding the Discussion!

At this time, it is possible to analyze the similarities between the sequences of all the different groups.

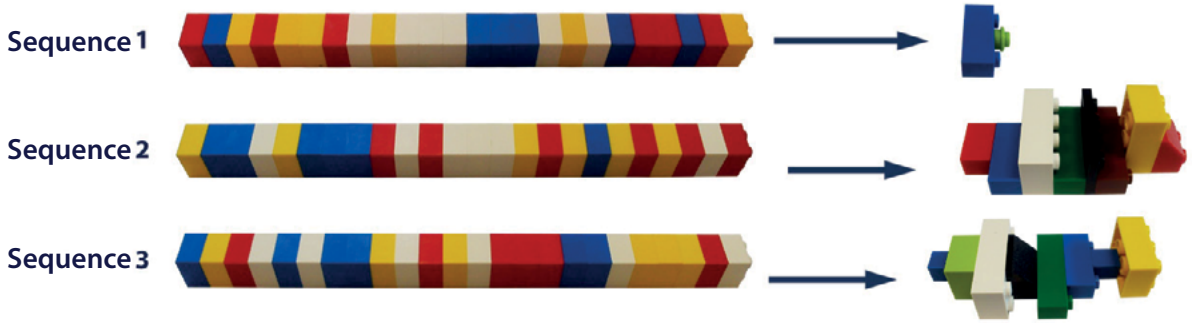


Discussing the different codes

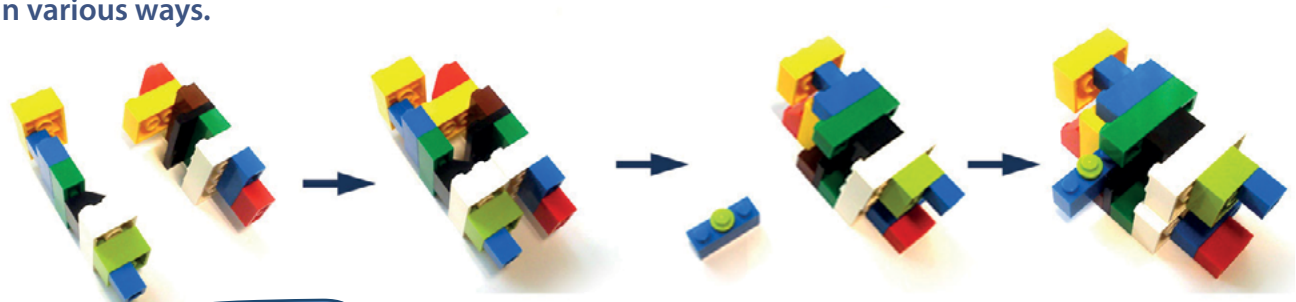
- Present the panel with the code so that the participants observe its characteristics like, for example: from the combination of four pieces united three by three, it is possible to obtain 64 combinations. However, these triplets are associated to only 20 new pieces (see Annex 1). As a result, some pieces are associated with one single triplet while others are associated to two, three, four or six triplets. It is important to highlight that there are triplets that are not associated to any piece (the end).

- Ask the groups to build, from their sequences of 24 pieces, the resulting product of the code provided by the table of color combinations.

- Ask the groups to compare the products formed and to draw their conclusions.



- Suggest to the students that they connect the different products, formed from their sequences, in various ways.



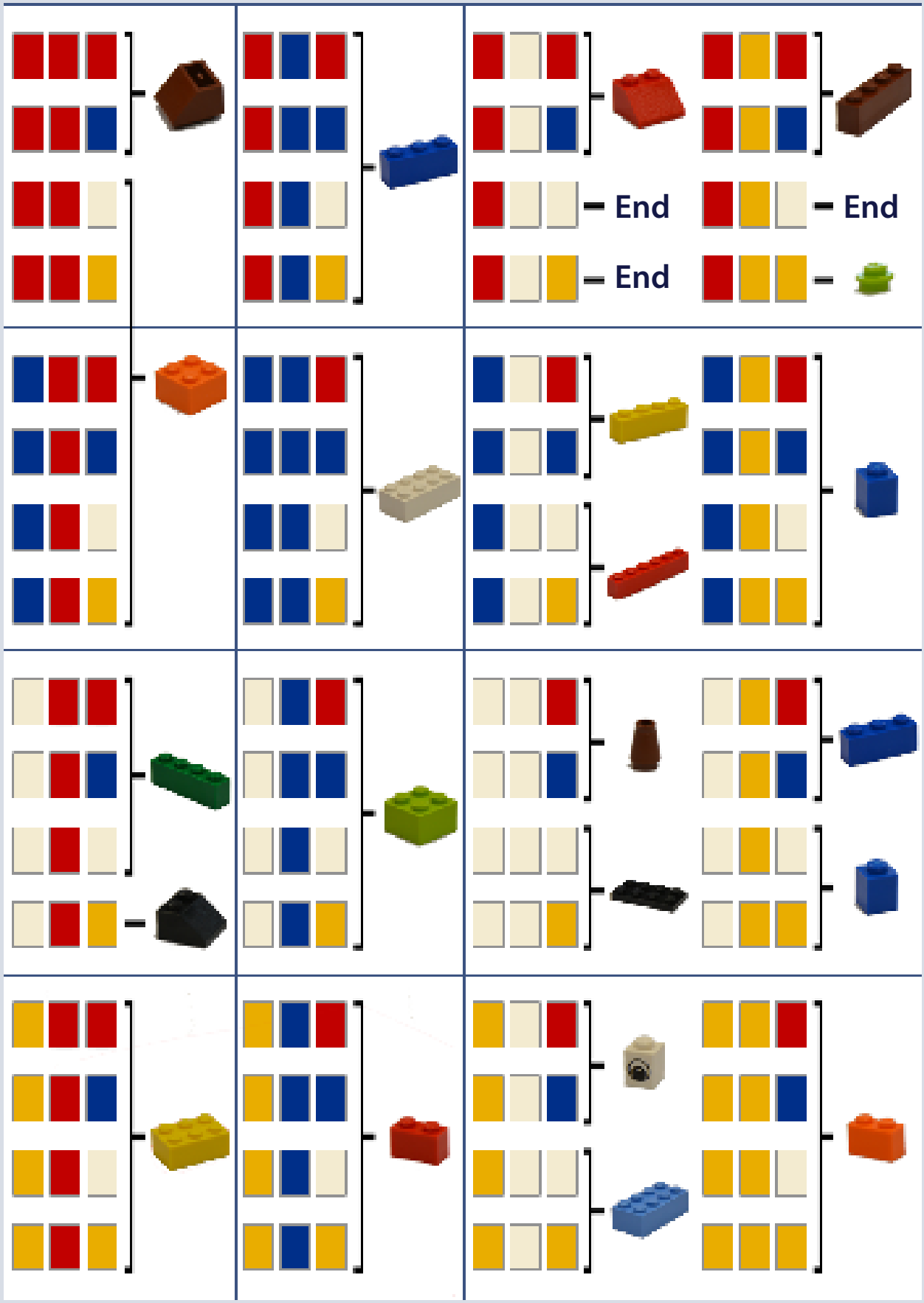
Expanding the discussion!

Observe that, because some triplets are not associated to any new piece, while some sequences can be interrupted, other sequences will not even be initiated. Ask the groups to divide themselves in two subgroups and build, from their sequences of 24 pieces, the resulting products. One of the subgroups will read from left to right and the other one will read it in the other sense.

Ask the participants about the possibility, starting from a given product, to find out which sequence gave origin to it. Highlight that, given the redundancy of the code, despite of the fact that it is possible to identify a sequence, there will be no guarantees that it is in fact the original one.

Anex 1

Deciphering the Code



Observe that, depending on the availability of pieces you have, it will be necessary to make changes.
Be careful, when making changes between pieces of colors or shapes that are different from the ones suggested here, to keep the correct relations in correspondence with the ones presented in this table.