UNITE for the Environment

Beekeeping and Guided Inquiry

1st Term 2020 – Teacher Training Manual

Learning objectives

- Analyze the purpose of bees in the community and ecosystem
- Describe the different beekeeping systems and best practices in beekeeping
- Explain how to attract bees into a new empty hive, catch a wild swarm, transfer bees into a hive, division of an existing colony and unite smaller colonies
- Demonstrate how beekeeping gear is used

INTRODUCTION

Beekeeping is the science and art of keeping bees using best practices. It implies the manipulation of a bee colony based on some understanding of the bees, use of modern techniques and tools in beekeeping. This conserves bees, gives great ease of management and harvesting for higher yields and better quality of honey.

There are various types of bees which include the stingless bees, solitary bees and honeybees. The common bees are honeybees, which are social insects that live in colonies of 10,000 to 60,000 bees. A colony consists of a queen (fertile female), a few hundred drones (males) and thousands of workers (sterile females).

Categories of bees

Queen bee: This is a reproductive female and there is only one queen in the hive and her job is to lay eggs and produce queen substance (pheromones). When a new queen starts life, she mates only once with drones outside the hive. A good queen lays between 1,500 - 2,000 eggs per day but after two years she lays fewer eggs. She lives for three to five years. It is very difficult to find the queen but she can be recognized by her long and slender body and short wings. She is fed by the young workers and is bigger than the other occupants due to massive feeding. She has a sting that is only used against rival queens. Her pheromones or scents serve to control the other bees and harmonize the colony's behaviour.

Drones: These are males and are bigger than the workers. They develop from unfertilized eggs and their major task is to mate with the queen. They are stingless, with very large eyes which are used to spot the Queen during mating. Drones look large and square and make a loud buzzing noise when they fly. Drones are dependent on the workers for food because their proboscis is short and cannot collect food for them. There can be about 200 to 500 drones in a hive but in time of food shortage the workers chase the drones out of the hive to die. Their lifespan is usually not more than 2 months.

The Workers: Most of the bees in the hive are workers- they are all sterile females. The worker bees' change tasks according to age. Young worker bees clean the hive, feed both young and the Queen and make the beeswax combs.

They control the temperature of the hive by flapping their wings and also guard the hive. Older workers scout for food and collect the pollen, nectar, water and propolis. They have a sting plus special glands and organs to help them to defend the colony against enemies. The workers are also responsible for the honey formation process.

The lifespan of a worker bee is 7-8 weeks during the main flowering season when they work hard. They can live longer during dormant periods.

Life cycle of a bee

Each bee in the course of its life passes through 4 stage metamorphosis: Egg→ Larva→ Pupa→Adult. During the development stages, the eggs, larvae and pupae are known as brood. The egg laid by the queen looks like a small grain of rice.

The egg develops into larva, which looks like a white maggot. All larvae are fed on royal jelly for the first three days after which larvae for workers and drones are fed on pollen (bee bread) and honey put into the cell by the nurse bees (younger worker bees). The queen feeds on royal jelly throughout the life.

Communication in bees

Bees communicate with one another in a number of ways such as drumming feet, flapping wings like a ‘dance’ and use of pheromones. The dance performed by the scout bees is one way the bees inform each other of the location of food and how far away it is. There are several types of dances performed by the bees, but the main ones are the round dance and the waggle dance. The round dance is performed by bees that forage less than approximately 100 metres from the hive. Waggle dance is performed to locate food source beyond 100 metres from the hive. The scout bees also perform a characteristic dance to locate the new found home to which bees intend to swarm.

The queen releases a substance called a **“pheromone”** (sometimes called queen substance) which enables her to identify members of the colony, to inhibit ovary development in worker bees, to prevent the workers from building queen cells, to help a swarm or colony to move as a cohesive unit, and to attract drones during mating flights. The absence of the queen substance (e.g. when the queen dies) produces opposite responses, i.e. worker bees begin to develop ovaries and to build queen cells, and a swarm searching for accommodation will not cluster but will divide into smaller groups that cannot support the normal life of a bee colony.

Colony decisions are taken by the collective behavior of bees within one colony sharing the same odor, allowing guard bees to detect intruders.

IMPORTANCE OF BEEKEEPING

Bee keeping has several values, unfortunately these are normally disregarded by many people, and beekeeping is mainly aimed at providing honey and related economic

benefits. However, if we aim exclusively at the economic side, and disregard the other benefits, beekeeping can't be sustainable.

Ecosystem services provided by bees

Pollination: 90% of all plants and over 75% of all the crops in sub Saharan Africa benefit from animal/insect pollination because they require cross-pollination to spread and thrive, and bees are our most important pollinators. Most plants require the transfer of pollen from the male part of the flower (the anther) to the female part (the stigma). As bees move from flower to flower in search of nectar, they leave behind grains of pollen on the sticky surface, allowing plants to grow and produce food. Bees earn their reputation as busy workers by pollinating billions of plants each year, including millions of agricultural crops. Without them, many plants we rely on for food would die off.

Bees are considered the most efficient pollinators because they have hairy bodies which easily pickup pollen grains as they move from one flower to another. Therefore beekeeping, increases bee population and this leads to increased crop yield through intensifying the pollination process

Sustaining wildlife: It's not just crops that rely on pollinators to thrive; many species of wild plants depend on insect pollinators as well. Bees are responsible for the production of many seeds, nuts, berries, and fruit, which serve as a vital food source for wild animals. These wild animals help in turn help in ecosystem balance.

Food Source: Bees produce honey to feed their colonies during the cold months in addition, humans have harvested honey for thousands of years, but we aren't the only ones who consider it as food, birds, insects and other animals sometimes raid beehives for a taste of nutritious honey (and bee larvae). Bees themselves are also a part of the food chain, at least 24 species of birds such as bee-eaters, starling prey on bees. Also, many spiders and insects, like dragonflies and praying mantises, eat bees as well.

Wildlife Habitats: Bees are known for their elaborate hives, but they also help build homes for millions of other insects and animals. Their role as pollinators is vital in the growth of tropical forests, savannah woodlands, and temperate deciduous forests.

Even our own gardens which are pollinated by bees serve as a home for hundreds of tiny creatures, from birds and squirrels to thousands of tiny insects. If bees disappeared, the animals that depend on these plants as habitats would vanish as well.

Conservation tool: Beekeeping is a nondestructive activity that could be employed in the conservation of biodiversity in natural areas. Households living adjacent to these areas can support the conservation efforts of these resources by establishing apiaries within or at the boundary of these protected areas. This is because setting up apiaries does not require one to clear vegetation and bees can deter animals such as elephants from invading human gardens and homes. Bees are also not prone to wild animal invasion like crops which can be eaten by wild animals such as monkeys and elephants, and domestic animals which can be preyed on by animals such as lions, leopards

Other benefits of beekeeping

Income and employment: The honeybee products can be marketed locally or abroad to get money, with or without value addition. Beekeeping industry also provides income to various stakeholders in the value chain. These include bee farmers, artisans, pharmaceutical industry, food, beverage industry, honey dealers among others.
Nutrition: Honey is delicious and nutritious. It is an important food for many people and can be consumed whole or mixed with other foods as supplement.
Medicine: Bee products such as bee venom, beeswax and propolis are used for treatment of many conditions following the antibiotic nature of the products. The conditions/diseases treated using bee products include stomach upsets, diarrhea, vomiting, wounds, burns, cough, measles, false teeth, toothaches and fungal infections. It also helps to boost the immunity of people living with HIV/AIDS.
Recreation: Other people keep bees as a hobby, establishment of bee reserves for purposes of tourist attraction and research holds a big potential for the future.

POLLINATION ACTIVITIES

Objectives

Students will

- Describe the process of pollination
- Identify the role of wildlife particularly bees play in pollination
- Describe how physical adaptations of plants and wildlife support pollination
- Identify flowers that could be pollinated by bees.

Background

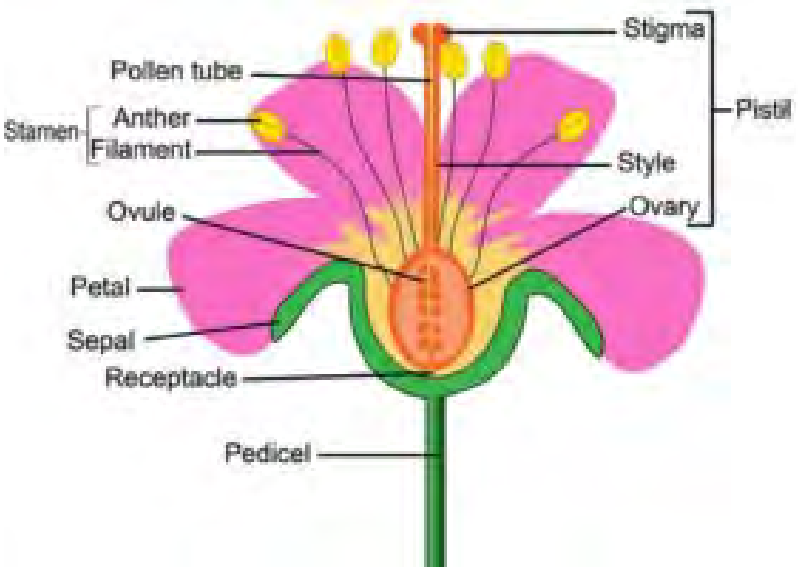
Reproduction is vital to ensure survival and continuance of every species. Plants, which are stationary and can’t search for mates, and therefore reproduce primarily through pollination. Think for a moment about all flowers you have seen. Many flowers are

fragrant (have pleasant smell) and showy (have colorful appearance). These traits are solely to attract a pollinator**.**

Some plants however have very small flowers or none at all. These plants are either pollinated by wind or self pollinated. Plants that are wind pollinated do not need a showy flower to attract a pollinator instead, wind pollinated flowers produce huge quantities of pollen which improves the chance that the wind will carry the pollen to another plant of the same species. Plants that are successfully pollinated will produce seeds.

To understand how pollination is facilitated by animals, one must first understand some parts of a flower. Although there are many different kinds of flowers, most flowers have same basic parts such as sepal, petal, stamen (comprised of the anther and filament) and carpel/pistil (comprised of the stigma, style and ovary).

Each part of the flower plays an important role in the process of pollination. The petals and sometimes the sepals are brightly colored to attract pollinators; the anther holds the pollen, which must be transferred to the stigma of the flower for pollination to take place. Most plants rely on cross pollination during which pollen is transferred from a flower on one plant to the stigma of a different plant of the same species.



Pollinators visit flowers to obtain food in form of nectar and pollen and because many pollinators have features such as tiny hairs on bee legs, that help to gather and hold pollen onto their bodies. As the pollinator moves to another flower, the pollen from the first flower is often deposited on the sticky surface of the second flowers stigma and will travel down to the style to the ovary of the second plant and the ovule (egg) is fertilized, and a seed will form. Without pollination a flower can’t create seeds

ACTIVITY 1:

Materials: writing materials, pictures or samples of flowers; copies of the data sheet and a close-up photograph of a bee on a flower

Level : Upper primary

Procedure

1. Discuss with students how plants reproduce. Why do some plants have flowers and what is the purpose of a flower? Have examples of flowers (photos, diagrams, real flowers) to show students. Older students may identify the parts of a flower and their function in pollination.

2. Describe to students the process of pollination (in background above). Students may be familiar with pollen –the yellow powder that accumulates in the air and on outdoor surfaces during certain times of year. In order for plants to reproduce, pollen must travel from one part of a flower to another. (In most cases involving pollinators, wildlife carries pollen from the anther of one flower to the stigma of another flower.)
An animal that provides this pollen transportation service is called a pollinator.

3. Ask students if they have seen any wildlife on or near flowers. What types of wildlife did they see?

4. After students respond, explain that there are many types of pollinators (bees, butterflies, moths, flies, beetles, birds, bats, etc.) and introduce bees as a "VIPs" –very important pollinators.

5. Ask them, why do bees visit flowers. What body parts help them collect and carry nectar and pollen? Why are these insects referred to as "busy bees"?
OPTIONAL: Use a close-up photograph of a bee on a flower to help students consider answers to these questions.

6. Now that students have an understanding of pollination, bees as pollinators, and the function of flowers, explain to students they will be going outside where they will act as bees to investigate flowers. Instead of gathering nectar and pollen, students will be gathering data!
Students will find as many flowering plant species as they can. Could a bee pollinate the flowers they see? Or do the flowers seem more suited for a different type of pollinator? Encourage students to keenly observe flowers so that they do not disturb bees or other pollinators that may be present.

7. Have students enter data directly into the Data Sheet and after students tally the number of different flowers they see, have them pick one flower to observe more closely. Students should note the flower name (common name, scientific name, or name created by student), brief description of the flower (color, petal numbers, size, etc.), location, a

sketch (capture the shape, color, etc.) of the flower, and their reasoning of why or how a bee would pollinate the flower.

8. Back in the classroom, ask students to discuss their observations.

Have students share the flowers they observed and discuss whether a bee is the most likely pollinator.

What other pollinators may be likely, if any?

9. Organize the data collected by students. Graphically represent the data by creating bar graphs, pie charts, or another chart type. How many different flowers were found? What colors were the flowers that were found? Were bees present on any flowers, or not? Did the bees seem to prefer a flower color? Were there other types of insects or wildlife on or near the flowers?

Data sheet

Name_____Date_____Time_____

Study Site Location_____

How many flower species did you count on the study site_____

Select one flower and fill out the boxes below

<table>
<tr><td>Sketch of the flower</td><td>Flower name</td><td colspan="2">Flower location</td></tr>
<tr><td rowspan="4"></td><td rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr></tr>
<tr><td>Number of petals</td><td>Color</td><td>Fragrance</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Flower description</td></tr>
<tr><td></td><td colspan="3">Why do think a bee would pollinate or not pollinate this flower</td></tr>
</table>

	Other interesting observation and findings
Wildlife data: Are there any bees or other wildlife on or near the flower, if so write down how many you see. If not sure of the animal, describe it.	

ACTIVITY 2

Grade Level: Lower Primary

Materials: Honey bee puppets, butterfly puppets, sunbird puppet, bat puppet, honey bee life cycle display, butterfly and moth life cycle display, twigs, colored powder, pictures, pollination board

Focus: Pollination- Students will learn about the different local pollinators and the role they play.

Objectives: Upon completion of this lesson students will:

1. Be able to describe two native pollinators. (cognitive)
2. Be able to demonstrate how to pollinate. (psychomotor)
3. Be able to gain a better appreciation for the native pollinators and the role they play in the environment. (affective)

Teacher Input: The teacher will show the class 4 different native pollinators by using pictures and puppets and show them the life cycles of the honeybee, butterfly and moths. The teacher will additionally demonstrate how honeybees visit many flowers.
To do this activity students will hold a flower cup in their hands while the teacher takes the honeybee puppet and visit each of their flowers.

Student Input: Students will be asked questions in relation to pollinators and pollination. Students will observe while different displays and pictures are shown. Students will have hands-on participation with the demonstrations and activities. Students will have to show how pollination occurs.
Guided Practice: Students will be divided into groups to go to the pollination station. Students will demonstrate how bees pollinate. Students will take a cotton ball (represents a bee) and dip it into colored chalk flour (represents pollen) filled flowers. Flowers will be filled with different colored chalk flour so students will see how bees pick up pollen from each flower and deliver it on too many flowers. Cotton ball will be colored up by all the many colors of chalk flour by the end of the activity.
Closure: Students will be asked questions to demonstrate what they have learned about pollinators and their roles.
Instructional Modification: Students in this class are very young therefore the teacher will be asked to provide help with hands-on activities and to help students that may have problems with comprehending lesson materials.

Reflections: Teacher will look at the strengths and weakness of the lesson after delivering it to the students and will evaluate the presentation and its format depending on how the students react to the taught information.

ACTIVITY 3

Materials: Stickers to represent pollen, popcorns to represent nectar, images of pollinators (bees, butterflies, moths) images of flowers

Procedure

1. Start the activity by showing students images of flowers with the pollinator on each flower. Include a variety of flower types and pollinators to aid in later discussion about physical adaptations.

2. Ask what is similar about each image. Students should mention that each image contains an animal (insect or bird) on the flower. Ask students what these animals are doing (eating). Explain to students these animals are visiting flowers to obtain food, primarily in form of nectar but also in the form of pollen. Nectar is a sugary liquid, and pollen is a yellow powder that is rich in nutrients. By visiting flowers, these animals often get pollen stuck to their legs, bodies, feathers, etc. what foods can students think of that sometimes stick to people's hands? Ask students to take a close look at the images. Have students point to the pollen stuck to the animal. Where else do they see pollen in the picture?

3. Inform students that plants produce nectar primarily so that an animal will visit the flower and then leave covered in pollen. Why is it important for a plant to cover an animal in pollen? Why is pollen so important to the plant?

4. Explain to the students that when the animal moves to another flower, this pollen is transported from the first flower to the second. This process is called **pollination**. When plants are pollinated, the plant produces seeds. An animal that moves pollen from on flower to another is called **a pollinator**.

5. Once students have been introduced to the concept of pollen, pollination and pollinators, establish boundaries for a playing field either in an outdoor area.

6. Inform students that they will be modeling the process of pollination. Although pollination can be done by many different kinds of animals, this demonstration will focus on bees. Divide students into two groups – flowers (75 percent of group) and bee pollinators (25 percent of group). It is important that there are more flowers than bees.

7. Give each "flower student" a paper bag filled with five or six small pieces of paper to represent their source of nectar. Also provide flower students with a sheet of stickers (*simple dot stickers work well*). Stickers will represent their pollen.

8. Give each “bee pollinator student” a paper bag to represent his or her stomach.

9. Explain to students that flowers do not move on their own, so flower students will remain rooted in one location. The goal of the flower students is to trade as much pollen as possible with other flowers. To do this, flower students put their pollen (stickers) on a bee’s back as bees bend over to pick up nectar chips; flower students also collect other flowers’ pollen stickers that are already on the bee. When flower students take a pollen sticker off a bee, the flower student should put the sticker on themselves.

10. Allow flower students to scatter themselves around the playing field. They will be representing flowers in a field. Align bee pollinator students in a line on the edge of the playing field.

11. The job of the bees is to visit as many flowers as they can to collect nectar (popcorns). It is important to note that bees can collect one nectar chip from each flower. Explain that bees must move around and not visit the same flower twice in a row.

12. Once flowers and bees are ready, start the activity. Allow the activity to continue for several minutes.

13. When the activity ends, ask bees to look inside their “stomachs” to determine if they have at least three pop corns. If they do not, they did not receive enough food and will be hungry. Ask flowers to see if they have at least three pollen stickers on themselves. If they do, they have been pollinated and they will produce seeds. If they do not, they have not been pollinated and will not make seeds. The teacher may go into detail about the process of pollination. Pollen must be deposited on the stigma of a flower for pollination to occur successfully. The more pollen that is transported from one flower to another flower (of a plant of the same species), the greater the chance that successful pollination and fertilization will take place.

14. Ask flower students to explain what their job was (to trade pollen with other flowers). What was the most difficult part of this job?

15. Ask bees to explain what their job was (to find enough food and nectar). What was the most difficult part of their job?

16. Did students observe any differences in how pollen (stickers) stuck to the bees’ clothes? Students should notice that the stickers attach better to smooth clothes versus bumpy or fuzzy clothing. This is actually the opposite of bees and pollen in the real world.

17. Ask students to take another close look at the images from the beginning of the activity. Ask them guiding questions to help focus their thinking on physical characteristics that aid in pollination:

- Where on the animal is pollen sticking? Where is it not sticking?

- Why is pollen sticking to these areas of the animal? Students should notice that the animals have structures (hairy legs, feathers, antennae, fuzzy body) that help pollen stick.
- Where is the nectar located? Where is the pollen located on the flower?
- Could a pollinator get the nectar without picking up pollen along the way?

Explain to students that the structure of the flowers and pollinators support pollination and ultimately reproduction and survival. Some adaptations make certain animals better pollinators than others. Encourage older students to consider whether all the pollinators shown would be equally good at pollinating each type of flower in the photos. Why or why not?

Honey formation process

Honey starts as flower nectar collected by bees, which get broken down into simple sugars stored inside the honeycomb. Nectar, a sugary liquid is extracted from flowers using a bee's long, tube-shaped tongue and stored in its extra stomach, or "crop." While moving around in the crop, the nectar mixes with enzymes that transform its chemical composition and pH, making it more suitable for long-term storage.

When a honeybee returns to the hive, it passes the nectar to another bee by regurgitating the liquid into the other bee's mouth. This regurgitation process is repeated until the partially digested nectar is finally deposited into a honeycomb.

To get all that extra water out of their honey, bees set to work fanning the honeycomb with their wings in an effort to speed up the process of evaporation.

When most of the water has evaporated from the honeycomb, the bee seals the comb with a secretion of liquid from its abdomen, which eventually hardens into beeswax. Away from air and water, honey can be stored indefinitely, providing bees with the perfect food source during cold months.

Honey's color, taste and flavor vary based on the nectar collected by the bees. For example, honey made from orange blossom nectar might be light in color, whereas honey from avocado or wildflowers might have a dark amber color.

WHY BEEKEEPING IS CONSIDERED A LOW-COST UNDERTAKING

(i) Beekeeping does not involve mass feeding of bees because in most cases the bees provide their own food all year round and can get additional food if needed from gardens in the neighborhood without causing any harm.

(ii) Most of the necessary inputs and technologies required for beekeeping are available locally. Some may be wasted if bees are not kept, e.g. pollen and nectar from flowering plants.

(iii) Honey and beeswax can be produced in semi-arid areas or areas with poor soils that are unsuitable for any other agricultural use.

iv) Beekeeping does not require a big chunk of land.

BEEKEEPING EQUIPMENT

Beekeeping equipments include beehives, harvesting gear, processing gadgets, and storage and transportation facilities.

1. **Beehives**

The best hive is one that is appropriate given the materials that are available, and the skills, financial resources of the beekeeper and is able to attract or house bees comfortably. For a beehive to attract bees, it should be dry, correct size, have nice scent and easy to protect from pests and predators. The simpler and cheaper a hive is to make, the more people will be able to take part in beekeeping. An expensive system does not necessarily result in higher output because honey harvests are also affected by the availability of forage for bees, the strength of the colony, and the size of the container used as a hive.

Practical activity: Making a beehive

There are different types of beehives, making different beehives requires different materials and procedures.
One of the common beehives is locally known as Kigezi/woven hive.

Materials for making woven basket/Kigezi hive include,

- ✓ Papyrus/ bamboo
- ✓ Odd number of sticks (9-17)
- ✓ Cow dung and ash for smearing
- ✓ Banana fibers or leaves for cover when the hive is ready to be set for bees

Procedure

1. Collect materials to use e.g. papyrus, sticks and cow dung in one place (These vary depending on the number and size of the beehives you want to make
2. Measure the size and shape of diameter you want. The recommended diameter for the opening should be 40 to 50cm while the closed end should be 10 cm less (the shape should be spherical)

3. Raise/erect the sticks, and split the papyrus for easy weaving around the sticks
4. Weave the sticks using banana fibers and or any other locally available threads in a spherical shape. The height should not be less than 3 feet and greater than 4 feet (<3 feet or >4 feet)
5. Smear with cow dung and ash let it dry for 4 to 5 days

TYPES OF BEEHIVES

Fixed comb (local/traditional) hives

Fixed comb hives are containers made from whatever materials are locally available, such as grasses, logs, bark, raffia palm, clay, etc. They include clay and log hives. Bees build their nest inside the container, just as they would build in a naturally occurring cavity. The bees attach the combs to the inside upper surface of the hive. The honeycombs need to be cut off from this surface to be harvested and cannot then be replaced. Fixed comb hives such as the hollowed-out logs, bark hives, clay pots and woven grasses, etc are cheap to construct, relatively easy to manage and suitable for defensive bees like in tropical Africa, including Uganda.

Woven basket hive

They vary in shape, size and type of materials used for example they can be conical or cylindrical in shape, the cylindrical one measures approximately 90 cm in length and 40 cm in diameter with one end completely closed, and the other end bearing 5 - 6 holes of diameter 8 - 10 mm in a row.

Materials used in making this type of beehive include papyrus, bamboo, fiber, twigs or sticks, cow dung or soil for smearing, grass or banana fiber or dry banana leaves as cover. Durability of the hive depends on the materials used and management.

This type of hive is cheap because one can use locally available materials and does not require a lot of skills and technology. It also leads to high propolis and wax productivity. They are however difficult to inspect, difficult to harvest, and swarming and absconding are common.

Top bar (transitional) hives

Top-bar hives are boxes with a series of bars arranged side by side along the top. Bees are encouraged to construct their combs from the undersides of these top bars. Top bars enable the beekeeper to lift individual combs out of the hive for inspection. Combs containing unripe honey or brood can be replaced and those containing ripe honey can be removed for harvest.

Harvesting honey and beeswax from top-bar hives is simple and can be achieved without damage to the colony

NB. All top bar hives should have bars with dimension of width of 3.2 cm and a length of approximately 48cm.

Frame hives

Frame hive is a box with movable frames. This type of hive is appropriate in tropical Africa but is expensive to buy and maintain, machinery is required to extract the honey. Beeswax yields from frame hives are low compared to fixed comb hives

APIARY MANAGEMENT

The location of honeybee colonies (beehives) is called an apiary. Beehives are hollow containers that can be closed and are purposely made to house bees, and these include:
A good apiary management starts with choosing a good site to hang or place hives. If you choose a poor site people and animals may be stung. If the site is insecure honey and hives can be stolen. Remember that once the bees enter the hives it will be more difficult to change things so choosing a good site to begin with is most important!

The following are recommended practices for a good apiary site:

- The site must be easy to get to and from in order for you to check the hives regularly.
- A high hedge or fence should be put around the apiary to separate the bees from people and animals, as bees can be aggressive.
- The apiary should be away from human and livestock dwelling areas, roads and public areas.
- It should be safe from strong direct sunshine, be shaded during the hot part of the day but have sun in the morning. Shade must be constructed if none is available at the site.
- It should be safe from strong direct wind and allow good air circulation.
- It must be near a fresh water supply; this can be a river, pond or even a dripping tap.
- It must be near food sources such as trees/nectar bearing crops, and cash crops that need pollination.
- Putting hives in a bee house/shed, which can be locked to prevent thieves stealing the honey, is one option. But there must be holes in the wall to allow the bees to get enough fresh air in and out of their hives.
- It is better if the apiary is away from areas where children play or any source of continual noise as noise can disturb the bees.

- To make them defensive, the apiary should be on higher ground, away from marsh or land liable to possible flooding. Humid conditions encourage fungal growth and prevent honey maturing and bees from foraging.
- The apiary must not be close to areas where pesticides are used as they may kill the bees and contaminate the honey.
- The bees will also appreciate being away from smoke, fire and unfriendly neighbors.

Hive Hanging (Demonstration)

The hives should be hung at waist height above the ground using trees or poles and strong greased galvanized wires to protect the bees from pests and hives should be in or under well-shaded trees. The height makes it easy for harvesting.

Suspend hives from wires so that predators such as the honey badger cannot push them over.

Traditional hives are usually hung in trees.

Alternatively, a hive can be suspended on a rope with a pulley that can be lowered for harvesting.

Hive Placing (Demonstration)

Place hives on sturdy stands especially hives which are not strong enough to hang.

Place hives to allow you to approach the hives from behind.

Placing hives on stands makes them accessible and easy to harvest and manage.

Remember the stand should be sturdy and high enough for the hive to be at waist height.

The stands of the stand must be smeared with ash to prevent pests such as ants getting into the hive and discourage grass growth near the stands.

The legs of the stand must be fitted with rat guards.

Alternatively, hives can be put under a shelter or in a bee house. This can be a simple hut with holes in the walls for bees to get in and out. A bee house is useful because it can be locked to prevent thieves stealing the honey or the hives.

Whichever method is chosen, it is always important to avoid long straight rows of hives to reduce drifting and disease transmission, to cut the grass short around the hives and to remove small stones or debris in the apiary as the beekeeper may stumble over them.

How to attract bees to the new empty hive

It often happens that bees do not enter the hive for quite a while. It is disturbing to see that the new hive that you have worked so hard to build stays empty and the empty hive does not produce any honey! There is therefore a need to attract bees to the new empty hive. To attract bees, the following should be considered

- Keep the hives clean and pest free – no dirt, spiders, cobwebs or insects.

- Place hives along the swarming routes of bees.
- Use bee attractants or baits such as beeswax, propolis and lemon grass (wax the top bars for example).
- Use bait hives and catcher boxes to catch a swarm.
- Transfer bees from a fixed comb hive or from a wild nest.
- Divide an existing colony.
- Buy bees.

Catching a wild swarm of bees

Swarming happens when the colony gets too big and the bees want to reproduce the colony by making a new queen. The old, experienced queen and most of the adult workers leave the hive with the swarm and fly out of the old hive looking for a new home. A new queen later hatches out and takes over the old colony and the remaining bees. The beekeeper can capture the swarm and place it into a temporary or permanent hive. The swarm has a better chance of staying in the new hive if it is captured during a nectar flow season.

How to divide an existing colony

Choose the strong, productive and less defensive colony to make divisions to increase your colonies. You can make a division of an existing healthy colony in order to colonize a new hive. Make division after the honey flow to increase colony numbers. The best time to divide a colony is when the bees are getting ready to swarm.

Avoid making divisions during the honey season because it will reduce the amount of honey to be produced.

Between the beginning and the peak of the flowering seasons, strong colonies can suddenly become overcrowded with clusters of bees near the entrance, and large numbers of drones. To check if a colony is getting ready to swarm look for signs that the colony is overcrowded and the queen has run out of cells to lay eggs in. A colony can fill between 9 and 15 brood combs with brood of all stages, including a lot of drone brood and sometimes there is even little surplus honey. Also, the bees will be producing queen cells. Dividing controls swarming and saves the beekeeper from losing the bees or the trouble of catching a swarm. But always choose the most productive and less defensive colony. By dividing it you are spreading its good genetic characteristics. To divide a colony, you must:

I. Prepare your new hive first – clean and rub it with some beeswax or propolis so that it smells familiar for the bees. Put it next to the overcrowded hive.

II. Use your smoker and suit and keep your smokers alight nearby in case you need it.

III. Choose a big healthy colony to divide and check it has brood, eggs, pollen and honey.

IV. Select a comb with queen cells (which have a small peanut shape), remove it from the hive and break all the queen cells except the biggest capped two. You need two just in case one gets damaged.

V. Now transfer the comb with the 2 queen cells into the new hive.

VI. Also transfer one or two other combs with a lot of sealed brood and a little unsealed brood. More brood means adult bees will emerge very quickly in the new hive.

VII. Also transfer one or two combs of food comb with lots of sealed honey and pollen. You can make a division with combs as long as the new colony has female worker eggs of less than three days old and larvae in the combs transferred. From the very young larvae they will be able to make new queen cells within a few days and raise a new queen.

IX. Include bees on all the combs you transfer and brush or shake in bees from 2 or 3 other combs as well.

X. Check very thoroughly that you DO NOT have the old queen on the combs you move or brush off. She must remain undisturbed in the old hive or mother colony. If you are in doubt then make sure you leave eggs and at least leave one big capped queen cell in the old hive in case you have taken her by accident. The bees will destroy the queen cell if the queen is present.

Remember to put the brood combs in the middle and the honeycombs on either side to insulate the brood nest. The framing combs feed and help the bees to keep the brood warm. Where there is no honey supplementary feeding can be done.

XI. These bees will become a new colony. Most of the adult bees will remain in the old hive and continue to make honey.

XII. The bees will look after the queen cells in the new colony and a new queen will hatch out. The first queen to hatch out will destroy the other queen cell.

XIII. Wait until dark then move the new hive to a site at least 2kms from the old site if possible.

XIV. If you don’t have a place to put the new divided colony 2 kms away then you must move both hives 1 km either side of the old location. This will ensure that some returning bees go into the old hive and some into the new.

XV. You will need to feed the bees in the new hive, as they will not know where to go and get food in their new place. A small colony can become weak very quickly.

XVI. If you see the queen or brood after 4 weeks then this has now become an established colony.

XVII. If you observe bees collecting pollen after two weeks, this is an indication that a new queen has emerged in that hive.

Uniting colonies

Beekeepers unite colonies in order to enlarge a colony, improve their yield of honey or control a worker laying problem. A colony can produce surplus honey only if it is strong enough and contains 6-8 combs with plenty of brood and sealed honey and covered well by bees. This very much depends on the colony having a productive queen. If a colony fails to produce surplus honey for 2 seasons, or if it is weakened by repeated swarming, then it can be strengthened. Two weak colonies can be combined to make one strong colony. One large colony collects more honey than 2 smaller colonies. A colony can be united with another colony or with a swarm. To unite a colony with another:

I. Remove and destroy the queen from the weaker, most defensive or least productive colony.

II. Catch and cage the queen from the other colony in a matchbox and place the hive near to the old colony.

III. Smoke both hives thoroughly so that their familiar smells are covered.

IV. To prevent bees fighting also dust them with flour or spray with sugar syrup – they will be busy cleaning themselves and will not fight!

V. Place the queen in her cage in the old hive next to the brood nest. The bees will chew the matchbox to release the queen.

VI. Transfer all the top bars with combs and bees into the old hive. Alternate combs from the different colonies as you do so until all the brood combs are united and then add the honeycombs.

VII. Close the hive and leave the united colony undisturbed for the next few days.

To unite a colony with a swarm you must:

I. Catch a swarm and if you can find the queen then cage her.

II. Open the hive and remove the old queen (undesired queen) in a cage and kill her later.

III. Smoke the bees and place the new caged queen near the brood nest.

IV. Shake the swarm into an empty part of the hive.

V. If you did not find either queen then do not worry. Leave both queens in the hive and the stronger one will kill the weaker one.

Note:

In the process of uniting the colony, you may experience swarming or absconding.

As the new colony has eggs and larvae in the combs they need to be protected. While uniting the colony the queen should not be kept away for more than 1 hour.

Transferring bees

It is possible to transfer bees from a wild nest or from a traditional hive with fixed combs (combs which are not moveable) in order to populate a new hive.

Transferring is not easy for the beginner. Transferring bees from a fixed comb hive is much easier than transferring bees from a wild nest.

Steps of transferring a colony:

(i) The best time to do this transfer is shortly before sunset NOT in the middle of the day. In the middle of the day, many worker bees would have been out of the hive foraging but in the evening they will have come back.

(ii) In some cases, wild colonies may not be easily accessible and may be difficult to transfer. Holes may have to be carefully cut in trees.

(iii) Use a lot of smoke to drive the bees away from the combs. Harvest the honeycombs into a bucket for processing. Make sure the bucket has a cover!

(iv) It is essential that combs be taken out of either wild nests or fixed comb hives by cutting them along the top where they join the container and without breaking them. Combs with large areas of brood and pollen are tightly tied one by one on to the top bars of the new hive. The combs should be touching the top bar. Strips of natural fiber such as cloth, cotton string, and banana stem fiber or acacia bark, can be used to hold the combs in place. Tie the combs to the top bars in 2 places for security. The bees will join the comb to the top bar and then break these down in time. Rubber bands and plastic string can be used but may cause problems because it is very difficult for the bees to cut them and they may damage the comb.

(v) Put one or two combs with brood tied onto top bars back into the nesting chamber of the original nest, from where you cut the comb. Leave it for 20 minutes. Smoke the bees onto the combs and let them settle.

(vi) Now place the comb, covered in bees, into the new top bar hive. If the bees are not stinging scoop the remaining bees very gently by hand (or using a pot) and put them in the hive with the combs.

(vii) It is good to place the hive as close as possible to, or on, the previous nest site or old hive site, so that foraging bees will return to it. But close the entrance to the original site securely with rags, sacking or newspaper to stop any bees returning there. Or remove the old hive, close it and put it indoors where the bees will not be able to find it.

(viii) Check the bees. If the bees have their tails in the air showing their white stripe then they are communicating to the other bees that the queen is there. If the bees are sitting in one place in the new hive then it is likely that you have the queen- it is not in the new hive.

(ix) If the bees are doing this fanning behavior with their tails in the air in the old site then you must capture the queen in queen cage and introduce her to the hive when the

rest of the transfer is complete. Place her close to the brood. Any remaining bees will come to the new hive if the queen is present.

(x) Alternatively, is to take several brood combs with sealed brood, eggs and pollen to the new hive.

Take as many bees as you can scoop in your hands also to the new hive. Take the new hive 3 kms or so away from the old nest site. This is a good method if you have trouble finding the queen as the new hive will simply make a new queen cell and form a new colony. This method is best tried near swarming season when drones are available.

It may not be necessary to take the new hive 3 kms away, just change the direction of the entrances of the old hive 180°, while maintaining the new hive in the former position of the old hive.

(xi) Alternatively, you can make wild bees swarm by smoking or hitting the tree in which they are nesting with a hammer continuously. The bees will leave and cluster outside. They can then be caught in a swarm bag and installed as a swarm. You may also place a bait hive near the site at swarming time and catch the swarm at the right time. However, the main problem with these methods is that the honey, pollen and combs from the nest will be wasted.

You can also use the above method to transfer a wild colony into a box or other traditional hive. After removing the brood comb from the old site, you simply lean the combs against the inside of your new hive or prop it up with a stick. You must be careful that both sides of the comb are accessible - the brood on the underside will rot if the comb is lying down and the bad smell will cause absconding.

Hive Inspection

Once the hive is occupied and the bees are busy, it is said to be colonized and it is important to inspect the colony to monitor its performance. Observe the following simple guidelines while carrying out inspection:

I. Do not stand in the flight path of the bees.

II. Work gently without excessive talking or banging noises.

III. Puff smoke gently around the entrance of the hive and remove the lid carefully.

IV. Remove a few empty bars to create a gap at one end of the hive. This should not disturb the bees.

Thereafter, remove one bar (for top bar hives) at a time. Smoke the gap gently and hold the bar vertically so as not to break off the comb.

V. Use a hive tool or knife to separate bars that are glued together by propolis.

VI. Keep the bars in the same order and try not to squash any bees when replacing them in the hive.

Squashed bees release a smell (alarm pheromone) that sets other bees on the attack.

VII. Do not visit the hive in the warm part of the day-about six o'clock in the evening is a good time.

VIII. Do not try and work with too many hives at a time, at least not more than 45 minutes in an apiary as bees from the first hive worked on will become agitated and attack, leading to further commotion amongst all the bees.

IX. Always wear light colored clothes. Ideally, protective clothing should be worn, especially a veil to protect the eyes and face.

X. Make sure the top bars are pushed together as they are replaced, so that no gap exists. Finally, gently replace the lid on the hive.

XI. Always keep the grass cut and the area around the hives tidy.

XII. Always extinguish the smoker if not in use.

Note the following during inspection:

1. Check on the strength of the colony by observing the brood: eggs, larvae and pupae.

2. Is the queen present? If she is hiding, the newly laid eggs can prove that she is present. Is the queen prolific laying enough eggs?

4. Is the colony healthy? Check on any indication of bee diseases.

5. Check on food stores (honey and pollen).

6. Is honey ready for harvesting? Indication is the capping of the honey cells. The comb should be capped/sealed on both sides.

7. Is there enough room for the bees? If not, remove some of the brood combs and unite with a weaker colony and replace with empty bars.

8. Are there indications of swarming? This is when they construct many queen cells or drone cells.

Destroy some and provide more room (as long as the queen is present).

It is recommended to keep simple but accurate record of each hive. To monitor the development in the colony, it is very useful to take notes in a notebook. After inspection, you should make note of what you have found in the colony and any adjustment you have made. For example, note the size or strength of the bee colony, the number of harvested combs etc.

In summary, keep notes on the following:

Date of inspection

Colony strength, i.e. number of brood combs, is there nectar, pollen, honey etc. Characteristics of the colony, calm, defensive, very defensive (sometimes some colonies can be so defensive that no inspection maybe carried out on that day).

BEE HARVESTING GEAR

Activity: Demonstration of use of bee harvesting gear and smoking procedure

Materials: Bee suit, bee gloves, gum boots and smoker

Procedure

- Briefly describe each of the bee harvesting gear
- Put on the harvesting gear (bee suit, gloves, gum boots)
- Put glowing charcoal on the sieve in the canon chamber, followed by any of the smoking materials such as semi dry grass, wood shaving, coffee husks, maize comb, bean husks, millet husks, etc, filling the chamber 3 quarter way.
- Before closing the smoker fill the canopy i.e. the last quarter with fresh green grass or leaves.
- Gently, start pumping the bellow and smoking.

Honey collection and processing premises:

1. The honey processing environment should be free of pests, contaminants and pollutants i.e. it should be free from filth, fumes, stagnant water/breeding places for mosquitoes, swampy areas, agrochemicals, human or animal waste or garbage.
2. The premises should be suitable in size for the purpose of handling/processing food
3. It should be spacious to allow smooth flow of processes
4. Adequate lighting should be provided
5. It should be vermin and bee proof
6. Have good drainage
7. Have a high roof and the ceilings shall be smooth, impervious and easy to clean

Record keeping

Good records kept by the beekeeper will help him/her to follow the general progress of his/her operations.

Two records are particularly important: colony and operational records.

Why should we keep records?

It is a good idea to keep records during each hive inspection so that you can follow the progress of each colony and monitor their condition. But bear in mind that each inspection should have some purpose and routine examinations should be planned.

Records can be kept so that you know what was done last time and what to do next time and what equipment you might need (such records can be used in teaching Math and Science).

Keeping records allows us to identify where we have made mistakes in colony handling.

Management records are for the beekeeper's individual benefit. Some people like to keep records of all their financial outgoings. From these they can work out when they might recuperate their costs from the sale of the honey or work out how much profit they will get.

Most of us can remember what is going on if we have one colony but what about 5 or 10? All the data collected is useful when the number of colonies has grown considerably and you want to start selecting the best ones.

You need records to have any chance of success in selecting good queens to breed or in rearing queens.

Records kept include: date/time of last inspection, forage and weather conditions, date of occupation/colonization, age of queen, date of last harvest, honey yield per hive, colony strength and growth rate (number of combs containing brood),timely manipulation (swarm prevention, feeding), amount of honey/stores in hive, characteristics of hive (defensive, calm, productive, poor), swarming record – how often, when and why, pests and diseases, hives name and number, type of hive, remarks.

Others are operation records such as visits to the apiary site, cash flow – how much money spent or earned, servicing of equipment.

BEE PESTS, DISEASES AND PREDATORS

Activity: Bee Aware of Danger

Introduction: The population of bees in Uganda and worldwide are reducing and this activity aims to encourage students to explore the decline of bees in Uganda, particularly around Kibale National Park.

Procedure:

Engage every participant to give examples of challenges faced in beekeeping within their locality.

Clarify, summarize and gives out at least 5 key challenges that directly affect the survival of bees.

Divide the class into five groups.

• Provide each group with a blurb on one of the reasons why bees are in danger.

• The groups should read the information that goes along with it

• Once they have discussed what they have, they must prepare a newscast sharing this information with the class.

• Provide the group with a few minutes to prepare the news report. Participants are invited to take roles as reporters, farmers, meteorologists, beekeepers or scientists.

• Each group prepares a 1-minute report telling the cause of danger and at least one suggestion for the viewer to try at home.

Examples of dangers for Bees

• Homelessness

Bees' nests are disappearing because there are fewer "natural" areas of farms where wild bees can live such as hedge bottoms and wild areas with long grass. Many areas are being disturbed by livestock such as cows. Try leaving some undisturbed areas (e.g. piles of grass clippings, areas of longer grass which are not mown) for bees to nest in.

• Hunger

There aren't enough flowers on some farms and bees need the food to last especially during rainy season. Try planting more wildflowers to help the bees get more food!

• Sickness

A very dangerous bug called the Varroa mite is causing the honeybees to become very sick because of the diseases the parasite carries. They attach onto the bee and are difficult to see. Try capturing them with a 'drone comb' or with powdered sugar!

• Poisoning

More and more farmers are using chemicals on plants to fight unwanted weeds and pests, but this is harming the bees. Try supporting organic farms in your area!

• **Changing Environment**

Extreme weather is causing plants to grow early and leaving the bees with less nectar when they are ready to collect it. Try planting flowers, herbs, and crops that will grow well.

Each group should share these presentations for the rest of the class. Encourage students to ask questions as audience members after each group presents.

Conclude with an overview of the five main reasons for the decline of bees in Uganda.

ICEBREAKER (UNDERSTANDING BEEKEEPING TERMS)

- Select a handful of important vocabulary in beekeeping.
- Move the participants outside
- Divide teachers into two groups and have half the group with words and half the group with definitions.

- See if the class can find their match by asking each pair to read a word and the definition
- Ask other participants views and if they disagree on the definitions, seek their thoughts
- Vocabulary words may include

Absconding: This occurs when all honeybees leave the hive or nest.

Apiary inspection: Routine observation of what is going on in and around the apiary.

Apiculture: The science and art of bees and beekeeping

Bark hive: Is a type of traditional or local hive made out of the bark of trees which can be built in a cylindrical or other shape.

Basket hive: Is a woven hive made out of various locally available materials.

Bee bread: Is a product of pollen and honey to make dough stored as food for the bees.

Bee brood: It includes eggs, larvae and pupa in a comb.

Bee brush: Used to brush off bees from the honeycomb during inspection or harvesting.

Bee calendar: Is what happens inside the hive all year round.

Bee Forage: Plants which provide pollen, nectar, honey dew and propolis for the colony.

Bee House: A house specifically designed with holes on the walls that are connected to the hive entrances.

Beekeeper's calendar: Is a series of activities carried out by a beekeeper during various seasons.

Bee Smoker: Is a simple device / tool used to generate smoke during hive inspection or harvesting to calm the bees.

Beeswax: Wax produced by honeybees and used to build combs.

Bee Venom: Is a poisonous substance produced by worker and queen bees for defense.

Build-up: Is a season when there are many bee forage plants and the weather is favorable, the colony expands.

Catcher box: Is a small hive with about 4 to 5 frames / bars used to trap passing swarms.

Centrifuge extractor: It is a machine used to extract honey from combs.

Comb: This is a hanging structure built by bees out of beeswax used for rearing brood and storing honey and pollen.

Comb Knife: Used to cut off honeycomb from a top bar or a local hive.

Dearth: Is a season when not much nectar is being collected due to bad weather and poor forage.

Frame hive: A hive which contains frames e.g. Langstroth, Dadant, and Smith. They all recognize the importance of bee space and use movable - frames

TEACHER GUIDED INQUIRY

There are four forms of inquiry that are commonly used in inquiry-based instruction. These are

Confirmation inquiry where learners are given a question, as well as a method, to which the end result is already known. The goal is to confirm the results. This enables learners to reinforce already established ideas, and to practice their investigative skills.

Structured inquiry where learners are given the question and the method of achieving the result, but the goal is to provide an explanation that is already supported by the evidence gathered during and through the investigative process.

Guided inquiry where learners are only given a question. The main goal is to design the method of investigation and then test the question itself. This type of inquiry is not typically as structured as the previously mentioned forms.

Open inquiry where learners must form their own questions, design investigative methods, and then carry out the inquiry itself. They must present their results at the end of the process.

The primary objective of guided inquiry is to promote learning through student investigation. In guided inquiry, learners are given questions and they figure out the method and outcome on their own.

Good guided inquiry questions should be measurable, interesting, and simple and can be done within a given time frame.

While guided inquiry is often student-led, it is also teacher-facilitated. Teachers ensure that curricular outcomes are met, that the learning needs of individual students are identified and addressed and that adequate resources are available. The teacher's role is one of 'guide on the side.' The teacher creates a platform for learning for students, gradually gets into the background as students develop their skills.

In guided inquiry, students have more independence, working from an assigned set of appropriate resources and determine for themselves which resources they will explore to answer the essential questions. The teacher helps to make sure their understandings are clarified.

Teacher-guided inquiry can build background knowledge of the topic before letting students take over in developing their own inquiry. With guided inquiry:

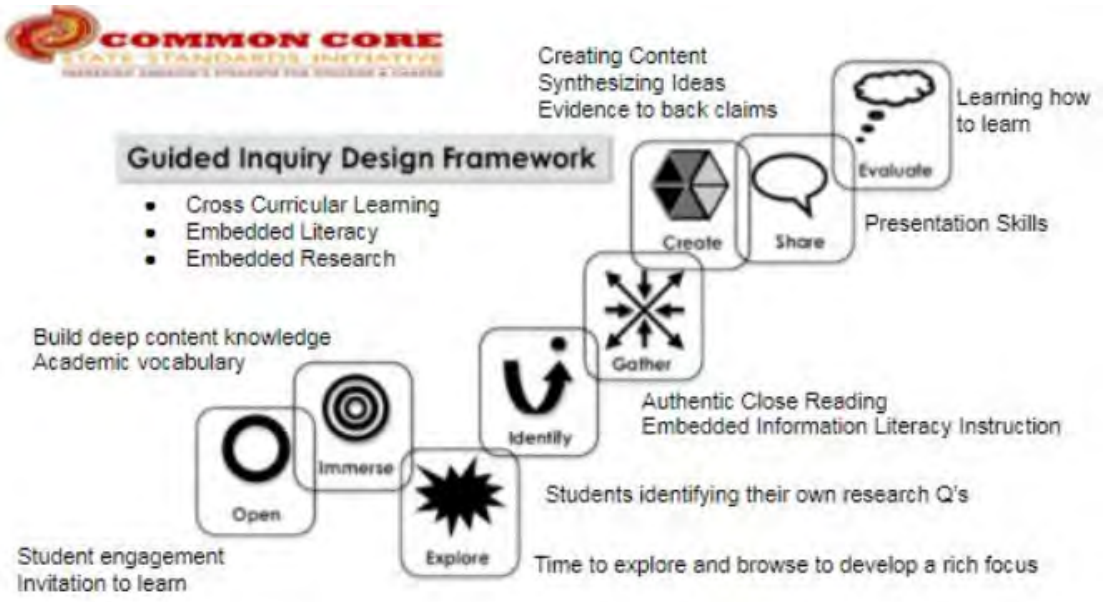
- Teachers start with an overall guiding question.
- Teachers know what they want their students to understand beforehand.
- Students know what the outcome of the inquiry will be.

The Guided Inquiry Process

Teachers support students who decide on an inquiry question and describe the known concepts that support their investigation. Students record the events that occur during their investigation and analyze how to summarize this new information. Finally, students interpret new information in light of the known concepts and their inquiry question; and summarize their findings.

Guided Inquiry Design Framework

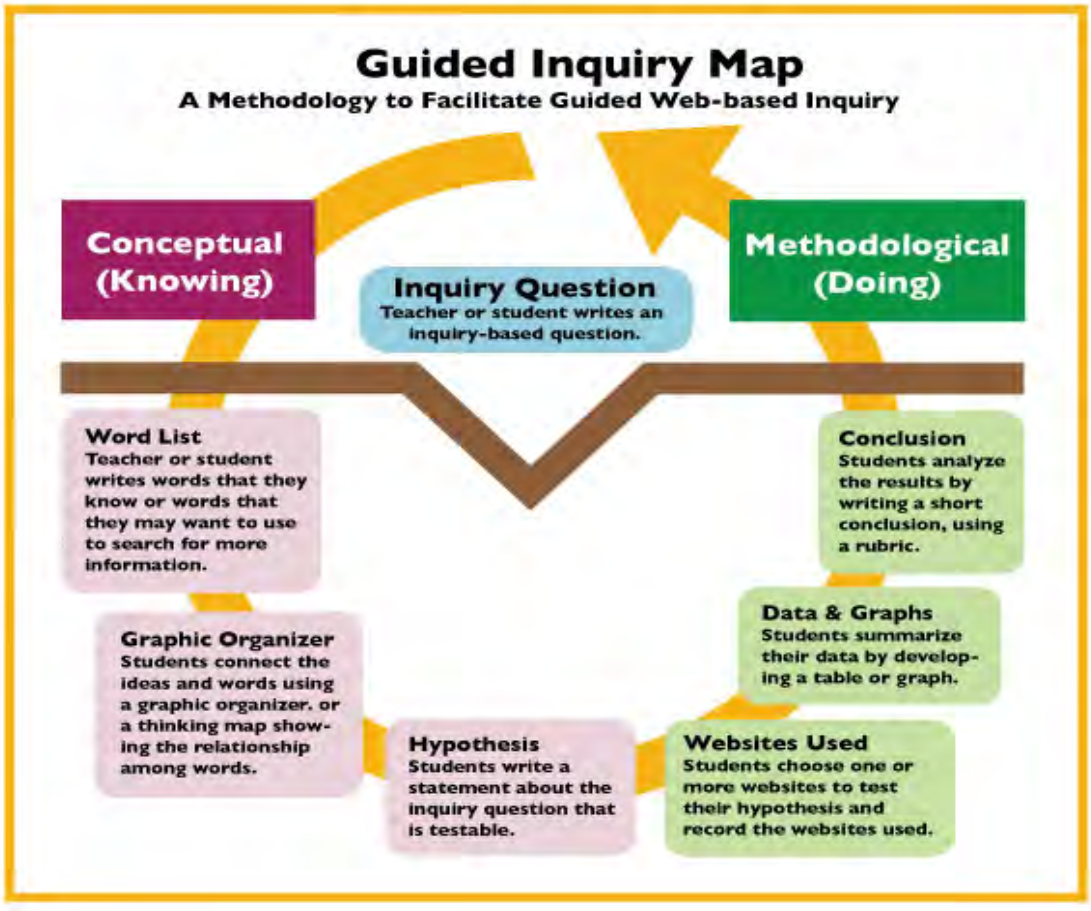
Guided inquiry design is a linear looking process since the process occurs naturally across time. Although each phase doesn't completely stand alone, one phase overlaps with the nest in the flow of connected learning experiences. This helps teachers to design inquiry-based learning as it will occur in their classrooms day by day across time.



Level	**What it involves**
Open	student engagement, inviting them to learn and stimulating their curiosity
Immerse	Building a background knowledge, understanding deep content and vocabulary, connecting content and

	discovering interesting ideas
Explore	Digging deep, looking around, discovering interesting ideas
Identify	Identifying inquiry question, deciding on direction
Gather	Collecting important information and going deep and broad
Create	Reflect on learning, making meaning of the facts collected based on facts, coming up with what to communicate
Share	Learning from each other and telling your story
Evaluate	Evaluate achievement of learning, reflect on content and process

Guided Inquiry Map



Activity:

1. Write an inquiry-based question e.g.

- How does the status/condition(well built, does it have leakages, etc) of beehives affect its colonization?
- How does the positioning of beehive affect its colonization?
- What influences the presence of animals on plants?
- What times of the day are bees most active?
- At what temperatures are bees most productive?

2. Divide participants in groups of 5 to 6
3. Work with each group to write words that they know or words that they may want to use to search for more information about the question and discuss the connection of word
4. Ask teachers to come up with ideas, and design how they are going to conduct their inquiry. This should include a materials to use, what they will measure (the data they will collect) and how they will collect the data
5. In their groups, move to the nearby apiary or outside to conduct the inquiry
6. Return to class and ask teachers summarize their data by developing tables or graphs.
7. Ask them to analyze the results by writing a short conclusion and share with others