The Groovy Gardeners

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Present: The Garden Update

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1 Problem Formulation

1.1 Introduction

The spring 2014 Engineering Introduction to Design class at Humboldt State University was approached by Zane Middle School in Eureka, California. Zane had a variety of projects that they wanted the design students to take on. Some of the projects included upgrading a school garden, building bird boxes, and building a water catchment system. The "Groovy Gardening" group chose to tackle Zane's school garden, which was in bad shape and in desperate need of remodeling. Even though participation in their barren garden was slim to none, the HSU gardening group could see that it had potential to be a beautiful and educational school garden.

1.2 Objective

The Groovy Gardening group's objective is to design/remodel the garden so that it is engaging and educational for the students. Designing a school garden for Zane that can get the middle school students engaged and actively participating in the garden will ultimately make for a successful public middle school garden. The objective of the garden design project can also be understood by Figure 1.1.

Figure 1.1: This is a black box model that shows a brief summary of our objective.2 Problem Analysis

2.1 Introduction

This problem analysis organizes the client's criterion so that the consequential constraints to each can be set up properly. This section will also include a description of our project's specifications, considerations, usage, and production volume to further explain the goals and what is needed to reach each goal.

2.2 Specifications

The project specifications include the following:

1. Using only organic materials.
2. Implementing the garden within the space the client has provided.
3. A document of instructions will be given to the client with information on how to keep the garden alive and fully functioning.
4. Seeds and starts will be planted by the Groovy Gardeners.

2.3 Considerations

A main consideration is that this garden has to be maintainable. The garden will be provided with the tools needed to keep it maintainable and ready to use.

2.4 Intro to Criteria and Constraints

Our criteria are listed in Figure 2.1 to provide factors that need to be considered while designing our project to enable us to make better decisions. These decisions are based upon the client and environmental constraints associated with each.

Criteria	**Constraints**
Cost	The allotted amount defined by client.
Low-maintenance	Between 1-2 hours of care per week.
Safety	Keep tools out of reach and grow nonhazardous plants.
Aesthetics	Looks healthy and bountiful, draws student attention and curiosity.
Timing/Productivity	Seasonal harvests should produce enough food to at least provide a monthly snack for students.
Integration	Provides snacks that the special education class can sell to other students.
Accessibility	Being able to fit a small class inside of the fenced-in area at one time.

Figure 2.1: Our list of criteria and constraints for our garden.

2.5 Usage

This garden will be used by the special education program at Zane Middle School. All classes will be able to access the garden year round in hopes of making the garden a place that the students want to visit. As well as the special education program the after school program is willing to help maintain and take care of the garden weekly. This should be enough help to where the garden will stay alive for years to come.

2.6 Production Volume

The garden is designed and built to produce food and other plants for our client year round.

2.7 Literature Review

2.7.1 Introduction

The purpose of this literature review is to present background information necessary for designing an upgraded garden for our client, Zane Middle School. By knowing what our client's expectations are as well as the variety of other factors affecting our design work, we will be able to better assess the task at hand.

2.8 Client Information

Zane Middle School has given us the task of updating their neglected garden. Currently, the school garden is composed of eleven large planters surrounded by a high, locked, chain link fence, and the only plant growing inside of these planters are onions. This could be primarily due to the fact that this area hasn't been easily accessible to the middle school students. Only the special education students are allowed to enter the garden, which restricts public access to it and lowers its ease of use. The group of students involved with the garden area is also in charge of selling snacks at snack time. The staff member that we met with suggested that we should incorporate those two elements by making it possible for the students to sell healthy snacks from the garden. There is also a tool shed located outside of the fenced in area that our client would like to have fixed and put inside of the fencing. We were also informed that there are two broken compost bins, in which we may be able to repair and incorporate into the school garden. Presently, this is what we know about the garden situation at Zane Middle School. We plan to continue conversing with the school administration in the near future to better understand what we have to work with and what their expectations are.

2.9 Successful School Gardens

To be successful, school gardens need to have: enough space, administrative support, enough money for garden supplies, and maintenance. Sponsors and grants are popular methods for gaining enough funds to appropriately care for a school garden. Having a passionate teacher who can dedicate his/her time to maintaining that aspect of the school can significantly determine that garden's overall success. If you are missing any of these elements, the garden will not be a success (Hohimer)

In "The Science Teacher" journal article, these same elements are suggested for a successful school garden. This article also added that involving parents is a great idea, because some of them might be more experienced at gardening and would love to help. Getting the school's groundskeepers in on the garden is also a good idea for when there are obstacles that teachers and students can't accomplish. "Developing a maintenance plan" is important in delegating the caretaking of the garden. It is important to have a schedule of who is taking care of what and when. Otherwise, the garden can be easily neglected for any given amount of time, and the plants might start to die. Another way school gardens can prosper is having them incorporated into classes at school. Eating what you grow in the gardens promotes good health and helps students understand the "you reap what you sow" concept (Beckrich 2011). By having more people help and be involved there is a much higher chance of the garden succeeding.

Taking pictures throughout the gardening experience is a good way to share what your school has accomplished and promotes the drive to keep the garden a success. Showing pride in a school garden by posting photos on the school website can lead to more student and parent involvement.

2.10 Curriculum

2.10.1 Principles of Curriculum

The curriculum should be engaging and enjoyable for the students and the teachers. The garden and the healthy lifestyle associated with gardening will not be successful if the students see the garden as just another chore.

The curriculum should also be simple so that the preparation time for the teachers is minimal. Few materials should be needed to carry out the lessons, and detailed background information is to be given. The detailed information allows for little to no research on the teachers end.

The garden should be used in conjunction with science courses already present at the middle school. The garden serves as a tool for kids to learn about nutrition, plants, and the animals that are attracted to the plants that are planted. It also helps to reinforce concepts that they are learning about in their classes.

All classrooms are different; what works in one classroom may not work as well in another. The goal is for teachers to take what they want from the curriculum and mold it to fit in their classroom. Teachers also have the option to alter the curriculum to meet the needs of their students (Education Curriculum, UC Davis).

2.10.2 Curriculum Organization

Each lesson in the curriculum provides a nutrition activity as well as a tactile gardening activity; the materials list and student assessments are also provided. School garden lessons start out with a quick review of previously learned material, because lessons branch off from previous ones. The nutrition segment of the lessons should take about one hour, while the hands-on gardening activity lasts about half an hour. These activities should be taught within a day of the other, since they are complementary. It is important to choose crops that will be ready to harvest by the end of the course. This will allow for the students to see a finished product, as well as eat something that they have grown themselves. Newsletters or emails should be sent to the students' families before the garden lessons are taught. The newsletters let parents/guardians know what their kids are learning in school. They promote family discussion and parent involvement; which is important to student success.

2.10.3 Suggested Strategies

It is important to emphasize the importance of a healthy lifestyle and to promote these habits whenever possible. Working with the school cafeteria staff to help solidify the bond between the lunch room and classroom lessons would be ideal. Posing health-related questions to students would allow them to critically think and allow them to make a connection between the food and their bodies. (Morris 2001)

2.11 Climate

Humboldt County has a rainy climate with temperatures between 50 and 60 degrees Fahrenheit year-round. Humboldt County gets anywhere from 40-100 inches of rain a year on the coast and just under that amount inland. There is also fog year-round that makes growing mold very likely in most areas. Having a garden in Humboldt County makes for easy watering because of the rain so the garden can rely solely on a rainwater catchment system. Making sure the plants do not get too much water will be a priority. With not needing to water all the time it makes this garden much easier to maintain. (Humboldt County 2013)

2.12 Soils

Plants are affected by the amount of water they receive at all levels of growing. At different stages of growth, plants need more or less water. If the moisture level of the soil is too high then the plants will give less yield of product and less quality. The amount of water they need depends solely upon the vegetable that is growing. Cabbage is most affected when the head is forming. Snap beans are most vulnerable when the seeds are 1 ½ inches long. This created a lower yield in overall product. Lettuce is always sensitive and creates lower yield, smaller head weight, and the quality goes down. The same rules apply for radishes and onions. Growth of these vegetables is relative to the rates of water absorption. The rate is determined by the content of water in the soil. (Singh, Ramadha & Alderfer, K.B. 1965)

These levels are dependent upon what crops are being grown. Organic matter is increased when the plants are soil-conditioning in nature. The organic matter always decreases no matter what crops is planted, some plants take more than others. Legumes add more nitrogen to the soil versus other plants. The Nitrogen stays close to the surface so is easily washed into waterways and the irrigation system. Legumes may add nitrogen to the soil, but they have a lower Carbon to Nitrogen ratio.

Decayed organic material is a known storage for Carbon. This form of storage is a major component of how much CO2 is released into the atmosphere. A main concern is that with the warming of the atmosphere, more CO2 is being released and contributing to that warming. Nitrogen is rapidly cycled through soil because it helps to decompose organic material with microorganisms. In some forms of fertilizer, nitrogen is added to compose material faster. Adding too much Nitrogen can be detrimental to the environment, because it pollutes water systems. (Harvard Forest 2011)

The pH balance of the soil is the key to healthy soil. The pH balance affects the composition and diversity of the microbial community and controls the amount of nutrients available to plants. The pH level is sensitive to the amount of amino acids in the soil. The amount of acids affects the concentration of inhibitors or activators that live in the soil. By finding a way to control and monitor the pH level, we would be able to grow crops without pesticides. The ratio of acid phosphatase and alkaline phosphatase is known as the ratio between acidic and non-acidic soils. This ratio has to be even in order to have the correct enzymes and bacteria growing for healthy soil. (Dick, W., Cheng, L. , & Wang, P. 2000)

2.13 Composting

There are many different ways to create and use compost. Compost is used for a variety of reasons including, fertilizer, potting soil, tea, and to add to common lawns. There are certain rules that need to be followed to have a successful compost pile. The first step is to have a proper place to keep it. This can be satisfied by using a large bin out of wood, heavy plastic or any local material you can find. Some bins are even specially made to turn and aerate compost as it decomposes to limit the amount of work in creating a pile. On an industrial scale, Windrows are long thin piles of compost where special forklifts and other machinery turn and take care of the piles.

Once you have a sufficient place, there is the question of what to add and how much to add. There are many things you can add to compost, from food scraps to wood and a variety of material in-between. The compost pile will only work if there is a correct ratio of Carbon and Nitrogen, the pH level is between 5 to 8, and the amount of organic material. The amount of organic material should be over 50% in order for a successful pile. Organic material is defined as plant and animal material without chemicals. The ratio of Carbon and Nitrogen is connected to how much organic matter as well as everything else was added to the compost. The ideal ratio is 30:1 in favor of Carbon. Materials that contain carbon are browned plants, wood products, and leaves. If they are left in larger pieces, then they will have to be filtered out at the end of the process, because they will not break down all the way. Substances high in Nitrogen are animal wastes, plant clippings, and various types of sludge.

The amount of time it takes for to full compost varies on what is in the mixture. One main factor of this is the temperature of the pile. The hotter the material, the faster the bacteria will grow and break the matter. In cold conditions, it is near impossible to have proper compost, because no bacteria and organisms will grow. Another factor is the moisture level of the material. If it has too high or low of a moisture level then it will not break down properly. It is not difficult to maintain the proper level by occasional watering and letting the rain water in the rest of the time. (Eartheasy.com 2012)

The garden at Zane would benefit from having a small compost to provide nutrients for the plants. The logistics of creating compost for us to use would include finding a teacher who is willing to learn how to manage one and take care of it in the future. We would also have to work with the kitchen staff on what can be added to the compost.

2.14 Plants to Grow

2.14.1 Introduction

Of the different types of plants we could have planned to grow for Zane's future upgraded garden, our team was limited due to the circumstances of our client. Our restrictions include growing plants that will be sustainable, low maintenance, available to our client during school seasons, and compatible with the rest of the garden's plants we choose to grow. Therefore, the

following plants were chosen for our client in hope that they will satisfy and meet all requirements for the existing condition.

2.14.2 Companion Planting

Companion Planting is being implemented in the *Garden Update*, because this method will, in theory, promote growth of the different plants. This method involves having plants grown in the same bed as those that will benefit them in some way. For instance, perhaps hypothetical Plant One is grown with Plant Two. Plant One might ward off pests that are interested in Plant Two, and Plant Two reinforces a good soil pH ideal for Plant One as well. This kind of companion planting also dictated which plants were chosen for this design project as well, which will be further explained.

2.14.3 Broccoli

Broccoli is an annual plant that prefers cooler temperatures around 15 to 25 degrees Celsius and should be transplanted (already with their seeds germinated) in May. This plant also prefers well-drained soil with a pH of 6 to 7.5 (Cornell University (1) 2006). To plant the starts is a similar method as Kale. The steps include: watering start; digging an inch to two inch deep hole in the soil; breaking up the start's roots; lowering it into the hole to where only its roots are covered; and then watering the planted start. When planting, however, if spaced 12 to 20 inches apart, they will grow larger heads, thus produce more per plant. Another piece of information to consider is the shallow root system of broccoli, which can mean the plants needing more water and can be coupled with a mulching system to increase success rate (Cornell University(1) 2006).

2.14.4 Parsley

Parsley is related to carrots and is a biennial (lifecycle lasting two years) plant that needs full sunlight for optimal growth. Also needing well-drained soil, parsley seeds should be planted by scattering them along shallow rows about ½ an inch deep within the earth, which one can do in the springtime. Sprouts should appear after about one month of germinating in the ground; and at that time, the plants should be thinned out, allowing about a 10-inch radius around each. In need of regular watering, these plants will be ready to harvest when it has grown into three leaf parts around the stems (Frogge 2004). Then, the harvested leaves can be added to a dish or stored and dried as an herb for later use. An issue that commonly appears, however, is that if seeds are first planted outdoors, due to slow maturing rates, weeds could cover the sprouts. Therefore, it is often advised to buy already-grown plants and put them in the earth. Oftentimes, parsley will withstand mild winters and continue to grow in ideal abundance (Editors of Sunset Books and Sunset Magazine, 1975. Pg 82).

2.14.5 Cilantro

Cilantro is a common, annual herb that prefers cool weather. Planted in the Spring, this plant can be harvested for its leaves 50 to 55 days after being put into the ground. The seeds, however, can be used as well and are known as "coriander". This plant grows anywhere from 12 to 18 inches tall, and it grows best well-drained soil containing a high amount of organic matter. This herb can be planted, as a start, with the same steps taken as kale, but should be handled carefully as the starts are more fragile. An important characteristic of cilantro is that the more leaves harvested, the more produced. One should harvest consistently and frequently to get the most out of the plants growing (Nardozzi 2014).

2.14.6 Beets

Beets are fairly low-maintenance crops to grow and are really a common plant found in the garden. They are resilient to heat and prefer cooler weather of temperatures of around 15 to 20 degrees Celsius. These plants prefer well-drained soils with a pH of 6.2 to 6.8, ideally. If grown from planting the seeds instead of the starts, they must be planted ½ inch deep in soil in rows ranging from 12 to 18 inches apart. As they grow, thinning must take place to promote healthy growth, and most plants will mature about 55-70 days after planting. One beneficial characteristic of beets is that they can be harvested at almost any time. The best time to harvest, however, is when they are standing 4-6 inches tall, and when the harvesting takes place, an inch of plant right above the roots should be left so that they don't bleed out their juice when cooked (Bennett n.d.).

2.14.7 Brussels Sprouts

Brussels sprouts are plants relating to the cabbage family. In fact, they look like miniature cabbages. They grow best in cooler temperatures and sprouts need a long growing expanse of time to mature. If planted in late spring/early summer, Brussels sprouts will generally produce well-matured sprouts in the fall. When planting Brussels sprout starts, they must be planted 24 to 36 inches apart in rows. They should grow into heads that are 1-2 inches wide and can be picked at this time. This should also be done before the leaves on the plants turn to a yellow color. After harvesting, the bottom leaves should be removed (University of Illinois (1) 2014).

2.14.8 Asparagus

Asparagus is a perennial crop that can produce vegetables for over 15 years. Preferring a soil pH of 6.5-7.5, these crowns can be planted as starts in mid-April to late May, and make sure that it is not too close to another crop as it can potentially block the other crop's sunlight. If taking the crowns, they should be planted, at the deepest, 5-6 inches deep, because research has found that the deeper planted, the less asparagus is produced. To harvest, the spears on the crown should be broken, with pieces 7-9 inches in length being harvested. Harvesting should only include taking from the plant above the soil, never below, and all of the plant's produce should be picked at once or else pests may be tempted to come and lay eggs in the spears. These spears will begin to grown when soil temperatures rise to around 10 degrees Celsius, and the harvesting process can then take place (Cantaluppi 2014).

2.14.9 Bush Beans

Bush beans are generally a really successful crop to grow; however, plan on leaving room for them to grow for they produce 2-3 more crops across the amount of space originally given to plant. These plants are annual and can grow up to 3 feet high and spread 2 feet in width. When planting the seeds, they will germinate in hot weather up to about 27 degrees Celsius and will emerge from the soil in around 10 days if these ideal temperatures are met. Also, when planting bush bean seeds, they need to be planted an inch under the surface of the soil and about 2 inches apart from each other. It is best, when watering, which should be regularly, to do so earlier in the day so that the leaves will dry and not promote disease (Cornell University (2) 2006). As they start to grow up perpendicular to the ground, they generally do not need any support, and they are ready to harvest anywhere from 57-65 days after being planted, which should happen in the Spring. Note when harvesting, bush beans have shallow roots, and they

should be gently picked when their pods are full in length and rigid (University of Illinois Extension (2) 2014).

2.14.10 Corn

Corn is an annual crop that requires warm weather to grow. This plant is slightly more difficult to grow than most low-maintenance crops; however, using a system of companion planting and growing corn with beans and squash, its potential for success will significantly increase. This crop reaches up to 6 feet tall and 1 ½ feet in width. It is recommended to plant corn starts instead of planting corn seeds directly for sake of time, also because adding the beans and squash seeds to corn that has already been started is most efficient. However, if planting seeds, they should be put into the soil an inch deep and 4-6 inches apart from each other. With shallow roots, making mounds with the soil around the growing corn can benefit its growth, and mulching will protect corn from failure (Cornell University (3) 2006). When harvesting the corn in the early Fall, grab the ear of corn and, twisting it down, pull it off the stalk. For a sweeter taste, one should harvest when each ear of corn peaks (National Gardening Association Editors 2014).

2.14.11 Kale

Kale is one of the oldest cultivated vegetables due to its low maintenance needs and ability to grow in an immense range of climates. It also is shown to satisfy as part of school meal regulations created by the USDA (Densham 2012). Planted first in the Spring, kale will take about two months to mature to standing around two feet tall, available as a “cold season” crop over a large harvesting window of time. Seeds should be sown an inch deep and apart from each other; and within seven to ten days, they should be fully germinated in the soil (Reader’s Digest 1995).

2.14.12 Celery

Celery is a seemingly “safe” bet to grow in Humboldt County due to its temperature conditions for optimal survival and growth. It needs a long period of time to grow in temperatures ranging from 60 to 70 degrees during the day, which correlates to the weather in this area. Best grown in soils with a pH between 6 and 7, celery seeds should be planted in the spring and spread about six to eight inches apart from each other. These plants must be kept moist; so by using a composting method, the seeds should mature within the next 180 days after seeding. The more sun celery gets, generally the greener its coloring is, and the more nutrient-dense the vegetable is; so making sure the plants aren’t shaded should be a considerable factor (Crockett, 88).

2.14.13 Strawberries

Strawberries, a very commonly-grown fruit, need to be grown in soil with a pH of 5.5 to 6.5, and typically grow best using a compost method. If planted in a location where raspberries, tomatoes, melons, or eggplants have been previously grown up to 3 years prior, the strawberries are susceptible to many diseases. This fruit should be planted in the spring with half of their crown buried in the soil, 2 feet isolated from each other (Crockett, 133).

2.14.14 Winter Squash

Squash come in many different varieties and sizes; however, winter squash would be most beneficial to a school garden considering that the students will be back in school at the time of harvest. Also, winter squash is low maintenance to grow. Two of the most common winter squashes, Butternut and Acorn, will mature 75 to 85 days from planting date. Other varieties may take up to around 100 days to mature. To ensure growth, squashes should be planted in a 12-18-foot deep/2-foot wide dug hole (Reader's Digest 1995).

2.14.15 Lettuce

Lettuce can be planted in spring, meeting the time restraints we have with implanting this new garden. It grows best in very rich soil using a compost method, and the seeds can be sown into the ground a half inch deep with an inch radius around them. Thinning should be practiced after the plants mature to about 1 -inch in height to give them each a 2-inch radius. The key to thinning consistently is to make sure the seedlings are not touching or "cluttered" within the garden. Needing to be watered consistently, lettuce grows best in a moist place. Harvesting can take place once the leaves have grown large enough to *gently* remove, leaving a tiny amount around the head to continue its growth (Reader's Digest 1975).

2.14.16 Cabbage

Cabbage is a vegetable with a wide range of acceptable climates for optimal growth. However, it grows best when the soil pH is between 6 and 7.5. One consideration of its ease in growth however, is that it is a crop that takes up a good amount of space. It is actually recommended to plant cabbage seeds in their own garden bed to allow growth (Reader's Digest 1975). Seeds should be planted around one half inches deep into the ground and later should be thinned so that each plant has a radius of 18 inches of soil around the plant. Generally planted in March or April, cabbage takes up to 100 days to fully mature to be harvest-ready (Wiberg, 47).

2.15 Garden Techniques

2.15.1 Tools

A list of basic garden tools includes a pitch fork, rake, hoe, watering can, square and round-pointed shovels, trowel, pitch fork, wheel barrow, and a hose (Gherig, 2008).

2.15.2 Starting Seeds: Germinating

Starting seeds indoors early will give a head start on the growing season, and is more cost effective than buying starts (young seedlings) at a store. Vermiculite is an inexpensive and lightweight medium for starting seeds inside, and its porous nature is effective for holding water. Sphagnum moss is often used with vermiculite to increase the moisture holding capacity. Compost is an ideal medium for starts but must be sterilized to kill off any diseased organisms and insect eggs. To sterilize, it must be spread in a pan and heated to 180F. The starting medium should be moist, but not soggy, as over watering will lead to fungal disease (Gherig, 2008).

For planting the seeds any small container (e.g. egg cartons, yogurt containers, a cut down milk carton,) will work. Seeds should be started in a warm room to keep the soil warm for germination. To expedite germination, seeds can be kept in the dark. Once sprouted, they should be moved to direct sunlight. When the seedlings produce their first true leaves (see diagram below) cut off all seedlings but the strongest ones. Once the remaining starts have 4-8 true leaves they are ready for transplanting to the garden (Gherig, 2008).

Figure 2.1: True Leaves compared to seed leaves
Gehrig, A.R. (2008). "Raising Your Own Vegetables, Fruit, And Livestock." *Back to Basics*"

2.15.3 Transplanting

2 weeks before transplanting, the seed starts should periodically be placed outside for increasing amounts of time each day starting with just an hour and increasing until they are out all day. This process is referred to as hardening off and readies the seedlings for being in the outdoors. Transplanting the plants on a cloudy day or in the afternoon will help avoid the drying effect of the sun. When removing starts from their container, allow each seedling to have as much soil around its roots as possible. Giving extra water to the seedlings will help ease the impact of the transplant (Gherig, 2008).

2.15.4 Water

Plants need water to survive. Heavy watering once a week is recommended instead of light watering daily. The watering should be enough to soak into the soil 12 inches deep to provide water to the roots. Watering in the late afternoon is optimal to prevent evaporation but still avoid the fungus infections of wet foliage. Over-watering wastes water, washes away nutrients, damages roots, and encourages the growth of disease-prone foliage (Gherig, 2008).

2.16 Irrigation Techniques

A simple lawn sprinkler or hand held hose effectively duplicates rain fall. A perforated hose can provide a long soaking directly to the soil, eliminating the waste from evaporation and runoff that occurs with overhead (i.e. sprinklers) techniques (Barker, 2008).

2.16.1 Dry Farming

Dry Farming is a passive approach to gardening that takes advantage of the water naturally present in soil. No water is added other than when the seedlings are first being transplanted. This technique's effectiveness is largely dependent on the geography of a garden site (Barker, 2008).

2.17 Landscape

2.17.1 Bed Shapes

There are a variety of shapes that are successful for plants to grow in. An "L" shape is effective for growing in a corner and extending along the length of a fence or other barrier. Terracing can be used to grow on a hill side with boards and stakes holding the soil in place (Gherig, 2008). A circular garden can be used in which corn is grown in the center, allowing beans to grow up the stalk of the corn, and squash grows on the ground in the outside of the circle (see "Three Sisters" below).

2.17.2 Raised Beds

Raised beds are intended to cope with poor soil or a lack of drainage. They are typically made with 2"x12" boards held in place by stakes. The size and dimensions of a bed should be determined by the convenience of accessibility. (Gherig, 2008)

2.17.3 Mulching

Mulching is a method of covering the top soil in organic matter. This effectively smothers weeds, and insulates and regulates soil temperature. As a result, moisture is conserved. Mulch should be applied in the spring; otherwise it will keep the soil unnecessarily cold and inhibit growth. Materials for mulching: sawdust, leaves, pine needles, straw and hay, old newspapers, wood chips, lawn clippings, and partially broken down compost. (Gherig, 2008)

2.17.4 Three Sisters

The Three Sisters consist of corn, beans, and squash. The corn is sown first, close together in the center of a mound of soil about 1' tall and 2' in diameter. Once the corn is 6" tall beans and squash are planted around it. The corn provides a terrace for the beans to grow up. The beans provide Nitrogen in the soil for the corn and squash. The squash acts as living mulch for the other crops: it insulates the soil and helps retain water for a longer amount of time, while preventing weeds. (Vivian, 2001)

2.17.5 French-Intensive Method

Planting densely can multiply the garden's yield per square foot. The French- Intensive method consists of working compost into soil until the top 12 inches are 1/3 to ½ organic matters. Seeds are then spread thinly in their designated areas over thoroughly soaked soil. The plants are thinned out after they start growing to about one half of the recommended spacing. (Gherig, 2008)

3 Alternative Solutions

3.1 Introduction

Through brainstorming sessions, alternative design solutions were developed. Each design satisfies the established criteria and offers feasible options for renovating the garden into a well-used, thriving space. A total of eight alternative solution designs were developed from two brainstorming sessions.

3.2 Brainstorming

There were two brainstorming sessions held outdoors with this same format. A design criterion was selected and solutions within that criterion were brainstormed for five minutes. After the time was up, we would take a one-minute break and then choose new criteria and start another five minute session. After two one-hour sessions, we had brainstormed under the following criteria: maintenance, safety, curriculum, productivity, aesthetics, sustainability, water, accessibility, plants, and a pathway.

Brainstorming included writing down key words that encouraged creative and abstract thinking towards generating solutions. Key words or phrases for criteria, specifically, included: low-maintenance, food, productivity, usage, water, space, timing, soil, location, aesthetics, interaction, climate, plants, growth, temperature, seasonal/time, learning opportunities, animals, classroom integration, companion plants, education, accessibility, success, and schedule. From here, the criteria were reduced to the most important aspects to the design project. For the alternative solutions, the following key words were noted: composting, food garden, glowers, transplanting, mulching, starting seeds indoors/outdoors, buying starts, and organic fertilizers. Also, constraints were set to brainstorm more ideas. These constraints, which generated pages of ideas, include: “CCAT” (hub for sustainability), “Plants” (which plants and how to plant them), and “Upcycled Pathway”. This type of brainstorming narrowed-down and categorized different aspects of the garden to be brainstormed.

3.3 Alternative Solutions

The following alternative solutions are products from the refinement of our brainstorms. Each solution has a detailed description of the specifics of the design, as well an illustration of what the alternative solution looks like.

- Bird’s Eye
- Fool Proof
- Schooled
- Tea Party
- The Hangout
- The Ultimate Plan
- Vegtacular
- Sustainable Learning and Living Garden

3.3.1 Bird's Eye

The Bird's Eye garden is completely bird and butterfly oriented. In spirit of the "secret" bird corridor nearby the elementary school, there are flowers and plants growing that will attract all flying friends to our garden. There are varieties of flowers growing whose seeds are food for many of the birds flying through the corridor and whose colors attract butterflies to come to the area. The garden is a local aviary hotspot.

There are hummingbird feeders lining the chain-linked fence on the inside, and more feeders that the students build may be added. The feeders increase garden use, associating the garden, as a whole, with arts and crafts and other animals. The bird feeders require students to consistently return to the garden to replenish them with bird feed or sugar water, depending on what kind of feeder it is. Giving students a responsibility will hopefully give them more of an incentive to keep up with the Bird's Eye garden.
Within the planter beds, there is a proportional amount of flowers to veggies and fruit growing. Different food growing for the students includes easy-maintained crops such as kale, squash, lettuce, strawberries, and other seasonal foods. This way, the garden space is being integrated as a shared environment for the students and flying animals. The use of flowers in the garden is not only for aesthetics, but a way to educate children in a creative way, using the birds for an interesting topic of interest.

Another aspect of this garden is the informational sign explaining different birds that can be potentially found within the area. This can inspire the students to spend time in the garden looking for the different kinds of birds and spur their curiosity for the natural habitat found within their school. This sign hangs in the front entrance of the garden for all of the students, even those not intentionally venturing into the fenced in space, to view the fun facts. If the students do venture into this bird sanctuary, they will find binoculars hanging on the fence so that they can be on the lookout for all of the birds flying around. The Bird's Eye garden design is shown below in Figure 3.1.

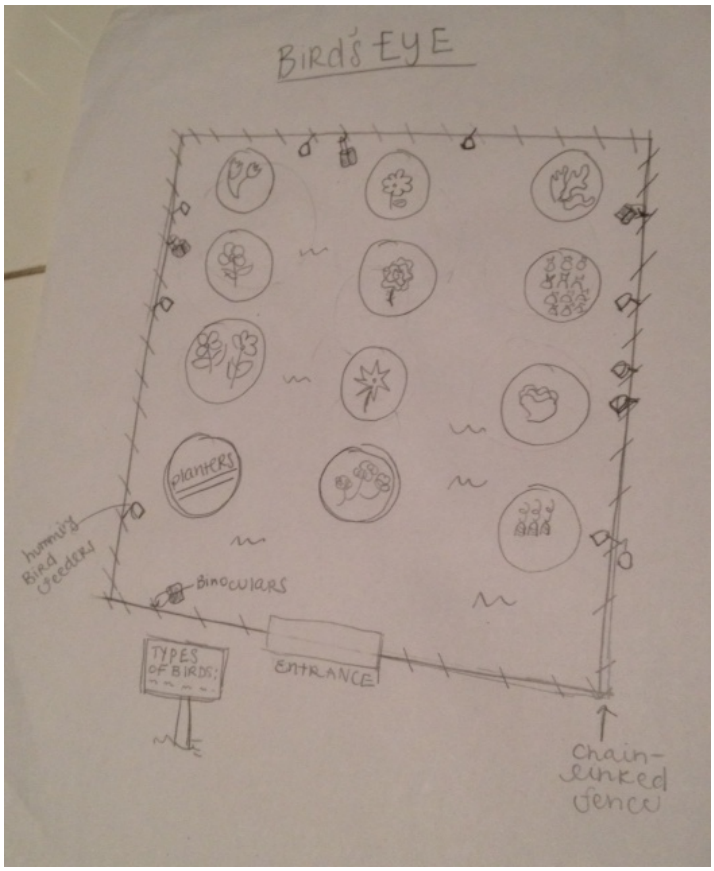

Figure 3.1: Bird's Eye Garden Overview (Illustrated by: K. Vincent)

3.3.2 Fool Proof

The "Fool Proof" option offers a simple and highly engaging approach to Zane's school garden. One of the most crucial elements of this option is the widespread participation it promotes. The garden is made apparent to everyone by organizing an after school gardening club, sending out a newsletter to parents to letting them know about the garden and allowing them to come in on weekends or after school with their children to participate. We would also like the custodians of the school to check up on it every once in a while, encourage teachers to take part, and even give students who are in detention the option to do some work in the garden instead of sitting in a room. If we can get everyone in on the garden there will always be someone looking out for it, resulting in a healthy and cared for garden. The more the merrier. This fool proof approach also consists of planting predominantly native, low maintenance plants/flowers. A simple guide to caring for the garden would be provided to the school, as well as a binder of school garden lessons that teachers can feel free to use in their classes whenever the opportunity finds them. Zane's garden will be watered the old fashioned way; with a hose when there has not been enough rain. A lock and timer will be implemented on the watering spout. The easier we make caring for and using the garden, the more likely it is that the garden will thrive and be a success.

Safety is made very effective, yet simple by keeping all of the tools, hoses and other gardening equipment in a locked shed that only supervising adults have a key to. All equipment/tools are to be put away after each use, to avoid any hazards. There will be a sign in/out sheet that keeps record of: who was in the garden, the supervisor of that group, and from what times they were in the garden.

This approach, even though it's very basic, still allows for the garden to produce enough harvest for students/participants to have a snack in exchange for their efforts. There will be enough diversity in the garden to have a good educational experience, and the planting of primarily native and low maintenance plants/flowers will still make for a very attractive garden. Some sort of natural glaze will also be applied to the planters to improve their look. This overview can be seen below in Figure 3.2.

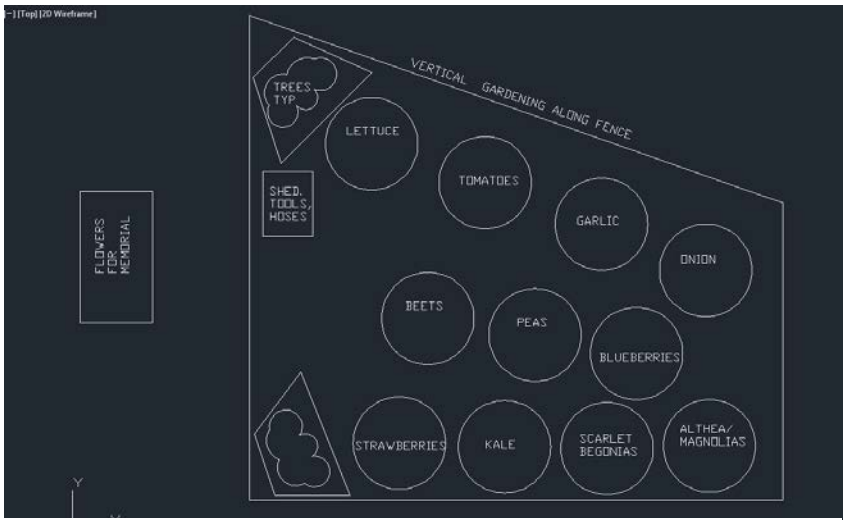

Figure 3.1: Overview of the Fool Proof Garden (Illustrated by: R. Williams)

3.3.3 Schooled

The "Schooled" garden that is implemented at Zane Middle School emphasizes learning by providing as many educational opportunities as possible within the garden. With the "Schooled" plan, students are able to intertwine the garden with all of their subjects in school. Each of the planters would act as a station where students can observe and learn about various subjects. For example, one planter contains plants that attract butterflies. Students can come out for science classes to observe the butterflies in the garden, and use that experience to better understand concepts taught to them in class. The garden serves as another way of learning: a more hands-on and visual method. When the garden is used in conjunction with classroom readings and lessons, it can lead to a stronger understanding of the material. Another learning station includes plants that attract birds, which the students could then study. Fruits and vegetables are grown to encourage a healthy lifestyle; they can also be cut up to help teach fractions.

Different types of plants and flowers are planted in each station: perennials, biennials, and annuals. Students can learn about these different types of plants and see what makes them

different from each other. Another planter station serves as a soil learning experience. Students can observe pH, moisture, and nutrient levels, and they have the opportunity to further understand what fertile soil actually is. A small solar panel is at one of the other planters. The middle school students can keep a school record of the amount of sunlight throughout the year, and they can use computer skills to make a graph that depicts the amount of sunlight the garden received throughout the school year. The learning opportunities that come with a school garden are almost endless; it will be up to Zane to determine the extent to which they want to incorporate the garden into classes. Figure 3.3 gives an overview of this alternative garden update solution.

Figure 2.3: Schooled Garden Overview (Illustrated by: R. Williams)

3.3.4 Tea Party

The Tea Party garden is currently growing multiple herbs used in tea and other types of food. There are common herbs like lavender, mint, lemon balm, rosemary, oregano, parsley, and an array of others growing in the beds. Each herb growing is labeled by handmade tags created by the students to display the variety to students or people in the garden who don't know where what herbs are.

To make this garden more interactive with the students, there is a solar-powered mini tea station, outside of the fence, made with the harvested herbs. The tea station provides students with different tea mixes each week in the morning before classes and on the student's snack breaks. In front of the tea set is a sign that tells the students to guess what is in the tea they are drinking, and on the back of the sign is be the answer. This way, the children can learn the taste of the herbs and associate the tea with the earth. The herbs not used to make tea are integrated into the cafeteria lunch food served to the students.

Part of the after school program is dedicated to gardening with these herbs and teaching nutritional information about each one- as well as the fun part: how to make different tea concoctions. This program is hoping to plan an actual tea party event held for the community using herbs from the garden in the near future. Shown in Figure 3.4 is an overview of the Tea Party garden.

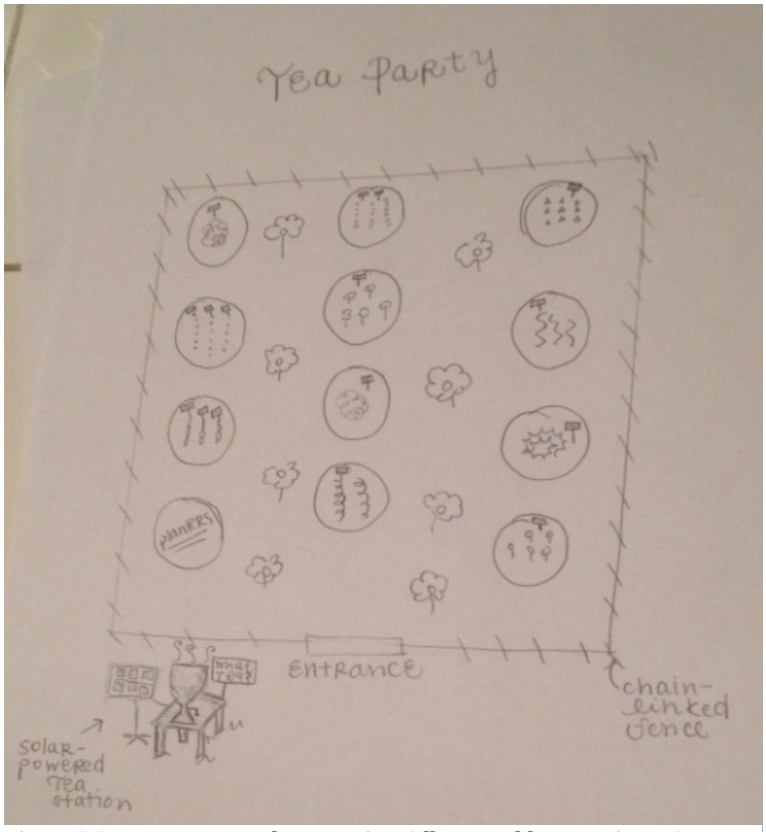

Figure 3.3: Tea Party garden overview (Illustrated by: K. Vincent)

3.3.5 The Hangout

The Hangout garden is a place where students can go and be at peace. This garden is presented as a safe, judgment-free zone where the children can express themselves through reading, writing, drawing, or even just hanging out in the garden on their free time. Growing tall garden are varieties of fruit trees as well as flowers, lining the garden protectively, separating the serene garden from the rest of the world. Grown within the beds are easily-maintained foods and herbs such as kale, squash, potatoes, strawberries, mint, and parsley, as well as multiple colorful flower varieties.

This safe haven includes a bench in the corner of the upcycled pathway, which winds its way around planters growing varieties of colorful flowers, fruits, vegetables, and herbs. At each twist of the pathway, next to each bed of growing plants, is an inspiration quote on a laminated sign whose leg is planted into the ground.

There are learning opportunities that can come with this alternative solution for the garden; however, its main purpose is to serve as safe place and to urge students to want to spend more time developing a connection with the outside world. This garden is also to spur unrestricted creativity in the arts, which will allow students to pursue their encouraged imaginations and ideas they have about the surrounding world. The garden is a place of inspiration and happiness, and it is a place we want the children to appreciate on a physical and emotional level, shown in Figure 3.5.

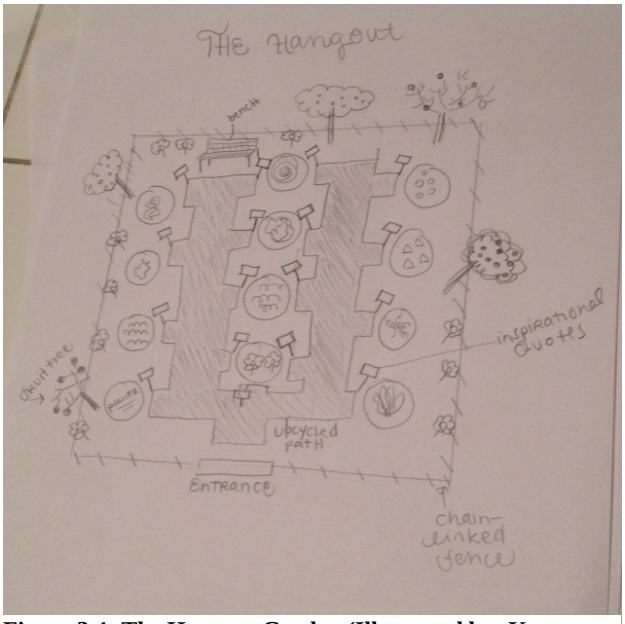

Figure 3.4: The Hangout Garden (Illustrated by: K. Vincent)

3.3.6 The Ultimate Plan

The Ultimate Plan is a slightly higher-maintained plan that has everything from fruits and vegetables to pathways and flowers. The types of edible plants in the garden are all the fruits and vegetables mentioned in the literature review: kale, garlic, corn, brussels sprouts, broccoli, beets, cilantro, winter squash, lettuce, cabbage, chard, beans, strawberries, and potatoes. Also included in these already-planted fruits and vegetables, the planting of beneficial herbs will be encouraged to the client.

Outside of the fenced-in garden is a memorial site along the wall of a nearby building. There will be flowers planted around the plaques after cleaning up the general area and inputting a gravel pathway. By extending the garden in this way, the memorial site will be better recognized and empathized at the middle school as well as have a small area in existence that is not gated.

Throughout the gated garden is another pathway, but this one is made of all upcycled materials such as concrete. The path is both aesthetically pleasing and keeps the students off the flowers.

The watering system is the rainwater catchment system that another team has installed. There is a wound-up hose located inside of the gated garden that can be easily accessed and hooked up to the rainwater system. This allows the students even more of a learning opportunity while integrating the two different design projects to get a task done. Not only is this educational, but it is also an easy watering option that is very straight-forward.

In order to keep the plants healthy, a small composting system has been implemented for the garden. The material comes from dead plants and leaves and is broken down to add to the soil for nutrients. There is a schedule in place regarding to the compost for the students. This schedule will explain when to turn the compost, and when it is ready to add to the plants.

There are garden tools that are locked up in a small storage box, a new addition in place of the vandalized, old shed. This will secure the tools while also making them more accessible to the students, who can be given the lock combination by a teacher when working in the garden.

The planters are painted vibrantly to bring more attention and draw people to the gated garden, which is hidden in the back of the middle school. The painted planters will add to the colorful aesthetics of the areas as well.

There is a set of curriculum and a simple garden guide given to the teachers explaining what is in the garden and how to teach the students valuable lessons about sustainability and living a healthy life style. This is implemented in an after school garden club where students work in the garden to keep it healthy and living. This is shown in Figure 3.6, below.

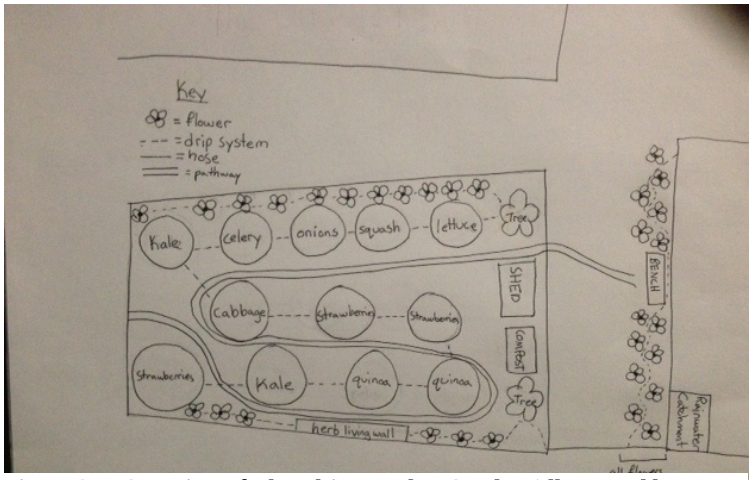

Figure 3.5: Overview of The Ultimate Plan Garden (Illustrated by: T. Hilden)

3.3.7 Vegtacular

This design includes mostly vegetables and grains. The plants growing in the garden includes: kale, celery, lettuce, squash, onions, and cabbage. Some of these plants, such as kale, will grow during the winter, which makes garden-produced snacks available all year around. A technique called the "Three Sisters" will be used to grow corn, beans, and squash. This technique is very productive; because the plants all help each other grow by providing nutrients needed by one another. The grain growing is quinoa, which is very nutritious and rising in popularity. Everything is planted in the cement planters that already exist within the gated garden space. The fruit trees that are already alive in the garden will be kept in their current condition, because there is no point in taking out a perfectly healthy living tree.

Also, the garden is extended over to the memorial site just outside of the garden gate, and there are planted flowers and trees surrounding the plaques and the bench already in place. By having flowers outside the garden and edible plants inside, there is a way to teach the students about them separately.

The garden is watered by mostly the rain water catchment system. When there is no water in the catchment system, there will be a hook up to a regular hose to water the plants; otherwise, the plants are watered by a drip system that has been placed in the planters and around the memorial site. This system saves water because it delivers water straight to the plants, so less evaporates. This system is installed underground so that the students will not trip on it or rip it.

All the tools are kept and locked up in the shed that is already in place outside of the garden gates. Having the tools locked up increases the safety of the students and security of the school's property.

There are two different types of curriculum that is provided for the teachers: one for the garden and one for the flowers in the memorial. By having two separate areas, the class can be split in half so it is not as crowded in one area, shown in Figure 3.7.

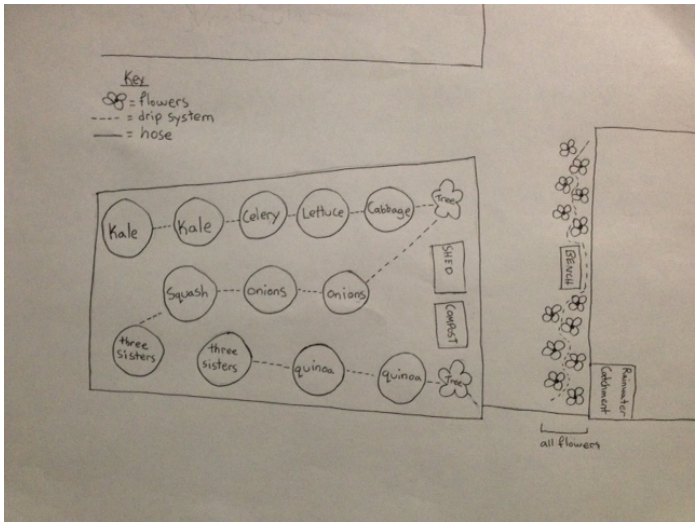

Figure 3.6: Vegtacular Garden Overview (Illustrated by: T. Hilden)

3.3.8 Sustainable Learning and Living Garden

The Sustainable Learning and Living Garden is provides a multitude of different types of learning opportunities.

There are signs painted, using natural paints, on each of the beds and elsewhere in the garden to properly label them and provide extra information. Some of the beds have explanations of what is growing inside of them and the benefits of growing those specific plant combinations. Other signs invite the students to figure out a math problem concerning the garden, or to write a poem or short paragraph about things they like about the garden. Another diagram elsewhere in the garden explains photosynthesis, and the importance of water in that cycle. This mentally and physically involves the students when they are inside of the garden.

Located inside of the garden gate, there is a permanent, sheltered "take-a-book-leave-a-book" library, encouraging students to sit in the garden or on the neighboring lawns and read a book.

The garden, of course, will have to demonstrate responsible water use. The primary source of water for the garden is from the rainwater catchment system designed and installed by another design group. The most efficient watering system for this specific design project's purposes is drip irrigation. This can be as simple as a hose with small holes strategically poked in it so that water drips directly into the beds and anywhere water is needed. Also, Hugelkultur, a water saving technique involving burying chunks of wood under a bed, is used to conserve water when there is limited rainwater. If needed, a hose can be connected to the drip irrigation system from a regular spigot as a "back up plan".

An upcycled path winds through the garden, creating an illusion of a much larger gated area. Also, the path leads outside of the gate to the edible landscape installations, and to the memorial garden. The memorial is renovated so that it is accessible and beautiful.

In each of the beds inside of the gated garden there is a variety of vegetables and fruits growing. Low maintenance perennial plants and hardy annuals are planted to minimize the human input on their growth. There is a seasonal calendar available that describes the tasks that need to be done to maintain a healthy garden during each season. Companion plants are emphasized, and there is even a bed dedicated to "The Three Sisters," which grows squash, corn, and beans, and explains the significance of this arrangement. Plants that could last through the winter are planted so that there is always something available to be eaten from the garden. Also, certain beds have small plants that could easily be snacked on, such as strawberries, snap peas, and radishes for example. Another bed demonstrates the "herb spiral" technique, a water efficient method of growing herbs, and has a brief explanation of each herb growing. Anyone is welcome to the harvest of the garden, but the primary users of the food are the after school group and Mr. Levy's special education class. They are also the primary volunteers at the garden.

To make most of the work in the garden work that students can do, a more passive gardening approach is used. Instead of laborious weeding, the students can just spread mulch over the

beds and smother the weeds; and instead of weeding the ground, low-maintenance, yet beneficial plants, such as mint, lemon balm, and plantain, are promoted to grow and can be trimmed back when they are unruly and then used or stored for mulching. All of these methods promote life and don't require any harmful pesticides.

Tools are kept in a small shed and can be locked when no one is using them. There is on-site composting of any food waste or other organic material from the garden, and also leaves and trimmings are used to mulch the beds.

For larger work that needs to be done, there is an annual community work day in the garden where students and their families, as well as neighboring community members all come down to the garden on a weekend day and put in the work to "reset" the garden. In parallel with that event, there is a community harvest event consisting of celebration and a potluck. All of this would build awareness and care for the garden. In addition, the garden fence is kept unlocked so that anyone can come in and enjoy the garden.

This garden is a campus hub for sustainability. It highlights the rainwater catchment, and also is near the edible landscaping installations. The entire garden has a low or negative embedded CO2 footprint, all materials and tools in the garden are claimed from the waste stream or upcycled. There is a bike rack along the fence line of the garden, so that students must come by the garden at least twice daily and also so that the eco-friendly alternative means of transportation is promoted. The garden is a judgment-free safe space that the students enjoy going to, and it is shown in Figure 3.8.

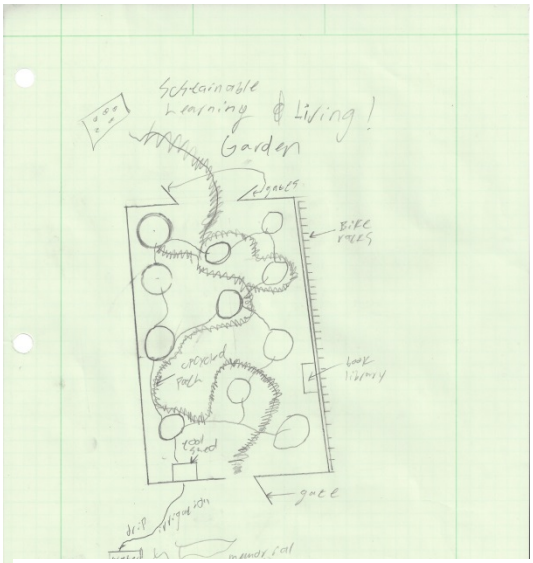

Figure 3.7: Sustainable Learning and Living Garden Overview (Illustrated by: P. Hassett)

4 Decision Process

4.1 Introduction

All of the preceding sections have enabled the Groovy Gardeners to make a thoroughly informed decision on how to approach the task of updating the client's garden. The final decision was reached through researching, brainstorming, considering available resources, gathering input from the client, and finally, the consideration of the Delphi Matrix results (to numerically find the best solution for the criteria needs), which was created after many steps in the design process that resulted in a list of criteria and alternative solutions.

4.2 Criteria definition

Cost – The amount of money the client is willing to spend on this design project is an important aspect of this project. For this specific project, Zane is willing to spend $100.00. The Groovy Gardeners want to keep costs as low as possible, ideally, lower than $100.00

Low-maintenance- To be successful, the garden needs to be easy to maintain. If the garden requires too much work, it may become more of a chore than a fun project for the staff and students. With the understanding that this garden needs to be low maintenance, the constraint for this criterion is that the garden must only require between 1 and 2 hours of care per week.

Safety- Being inside of a school, the garden needs to be a safe place for the students and anyone working in it. There are tools for the garden, and keeping them locked up would ensure that the teachers can oversee who uses them and when. This is necessary. Another safety concern is the plants growing inside of the garden, which leads to limiting what is grown in the garden: no hazardous or poisonous plants and no pesticides. These are two constraints that will be seriously implemented in the decision process.

Timing/Productivity- In order to ensure that there will be harvestable edible plants from the garden for the school to use, a constraint must be set to what is planted within the garden space. With research, it is understood that certain plants are grown in certain times of the year, and timing determines how much of each edible plant is produced. To make sure that the garden is producing enough, the following constraint has been set in place: seasonal harvests should produce enough food to provide, at least, a monthly snack for students.

Aesthetics- A garden, naturally, should provide color and nice aesthetics; however, it is still an important aspect to this design project. People need to care about the garden and appreciate it. Aesthetics will add much to this generated appreciation, especially since this is a predominately appearance-based society. The garden must look healthy and bountiful, and it must draw in student attention and curiosity.

Integration- Integrating the garden into the classrooms will encourage the students to spend more time in the garden, adding to its maintenance and success. The garden needs to be able to be incorporated into a curriculum for the classes in some way.

Accessibility- Tools in the garden, such as the hose, shovels, trowels, gardening gloves, and other necessary garden tools, as well as the garden itself, need to be accessible to people for use. Otherwise, the responsibility of taking care of the garden would be placed on one person, less people, or nobody, which could contribute to its hypothetical failure.

4.3 Solutions

Each alternative solution brainstormed is listed below.

- Schooled
- Tea Party
- Bird's Eye
- Sustainable Living and Learning
- The Hangout
- Fool Proof
- Vegtacular
- The Ultimate Plan

4.4 Decision Process

The first step of the decision process was weighing each of the criteria on a scale from 1 to 10 (10 being the highest). Then, they were collaboratively scored on how well each of the alternative solutions addressed each criterion on a scale from 1 to 20 (20 being the highest). The Delphi Matrix, shown below in Table 4.1, was then utilized, and each alternative solution was given a final score. The solution with the highest score is considered to be the best fit for our criteria.

Table 4.1: The Delphi Matrix shows a ranking system that lead to the final decision. The matrix takes the overall criteria rating and multiples it by a different ranking given to each specific alternative solution.

		Schooled		Tea Party		Bird's Eye		SL and L		The Hangout		Fool Proof		Vegtacular		The Ultimate Plan	
Criteria	Weight	Score	x Weight	Score	x Weight	Score	x Weight	Score	x Weight	Score	x Weight	Score	x Weight	Score	x Weight	Score	x Weight
Cost	7	8	56	8	56	10	70	14	98	9	63	12	84	16	112	14	98
Low Maintenance	10	12	120	10	100	13	130	17	170	14	140	14	140	16	160	17	170
Safety	7	15	105	11	77	16	112	16	112	18	126	18	126	17	119	18	126
Productivity	7	12	84	12	84	13	91	17	119	14	98	15	105	16	112	16	112
Aesthetics	6	15	90	16	96	17	102	17	102	17	102	15	90	15	90	17	102
Integration	6	19	114	12	72	13	78	12	72	10	60	17	102	16	96	16	96
Accessibility	9	15	135	17	153	16	144	17	153	10	90	17	153	16	144	16	144
Total Score			**704**		**638**		**727**		**826**		**679**		**800**		**833**		**848**

4.5 Final Decision

The Ultimate Plan solution has been decided on for the final solution for this design project due to it having the highest ranking, found by the Delphi Matrix. This solution best fits the criteria established. It includes curriculum for classroom integration, it is low maintenance, safe, cost efficient, and allows accessibility. This plan has an angle for all of the criteria presented and it the most efficient alternative solution to implement for the Garden Update design project.

5 Design Specifications

5.1 Introduction

Section 5 of this document includes a more detailed outlook of the final solution decided upon for the client. In this section, the specifications of the garden will be further analyzed. This analysis includes multiple views of the solution; costs of materials, implementation, maintenance; and a chart presenting the amount of design hours spent on this project. This section also includes how to maintain the garden so that it will remain successful.

5.2 Description of Solution

The Garden Update's final solution is multi-faceted. It includes plants that are low maintenance, accustomed to Humboldt County's climate and Zane Middle School's conditions, as well as other key additions. Also in the garden is an upcycled pathway, an included binder of curriculum and crucial information, working tools for students and staff, and a hanging mini herb garden.

5.2.1 Planter

In the planters, we have a variety of plants being grown. Growing in the planters are different varieties of kale, chard, strawberries, quinoa, squash, sweet peas, potatoes, garlic, beets, and lettuce. All of which are low-maintenance and suitable for Zane's conditions. In multiple planters, there are more than one type of plant growing. The plants are strategically planted to where they will benefit from each other and grow healthier. Incorporated into multiple planters to benefit the plants, dead organic material has been placed in the planters so that over time it will decompose and add more nutrients to the soil. This process is called mulching and ideally, will increase the potential for success in the updated garden. Overall, all of the processes taking place within the planters will hopefully best-fit the needs of the garden coupled with the affordable abilities of the client.

5.2.2 Pathway

We have incorporated an upcycled pathway that winds itself around and through Zane's garden. This pathway is designed to keep students off of the ground where flowers and other plants will be growing. The pathway is made from old pieces of concrete, tile, and granite. The pieces were found at Alves Inc. in a pile ready to be recycled. These materials were perfect to use, not only because they were free, but also, reusing a material that is commonly bought. The

pathway will serve as an enhancer to the garden's aesthetics as well as implement a special journey through the garden that passes each garden planter growing different plants and foods.

5.2.3 Ground Space

The ground space between the planters has flowers and a pathway. There are a variety of flowers that will attract bees and other small creatures to our garden. Having these "extra" plants and flowers apart from the main attraction, the planter food will spark a sense of further educational curiosity. The students will then have not only a garden that grows food, which is also an important connection to make for children, but leave the school as a place filled with different learning opportunities. How is this provided? The garden will be diverse, and with this diversity, there will be so much to learn, experience, and appreciate within the gated door.

5.2.4 Curriculum and Information

The garden has a class curriculum and other information that has been given to Zane. In order to motivate the teachers to allow students out into the garden, the client has been left with a binder full of information such as class activities, ways to integrate the garden into a learning experience, and information about all of the plants. This includes when to harvest, water, and how to upkeep in general. Providing this information makes the garden not a task, but a simple classroom tool with all of the information already researched and presented right before the client. This information is crucial in adding to the success of the school garden.

5.2.5 Memorial Site

The memorial site located right outside of the garden is somewhat unrecognized under the overgrown grass and un-kept area surrounding it. In order to give the memorial more significance and recognition, tending to the overgrown grasses surrounding the site and planting a variety of flowers have been done around it to emphasize that it is there.

5.3 Costs

During the course of this project we had a strict budget and stuck to it. The costs include the amount of money we spent as well as what was donated.

5.3.1 Material Costs

Our team goal was to spend as little money as possible. We achieved this by using materials that had been considered "waste" as well as getting multiple donations. Our total cost came to $198.00 even. Within that amount $150.00 were spent by Zane on a new shed making the cost to our team only $48.00. Figure 5.1 shows a more detailed list on what was spent and donated to us.

Garden Update Costs				
Quantity	**Material**	**Source**	**Our Cost ($)**	**Retail Cost Total ($)**
1	Pack of Quinoa Seeds	Seed Exchange	-	$1.99
1	Flat of Chard Starts	Baysisde Park Farm	-	$12.00
1	Pack of Kale Seeds	Seed Exchange	-	$6.69
1	Flat of Kale Starts	Baysisde Park Farm	-	$12.00
1	Strawberry Starts	Farmer's Market	$10.00	$10.00
7	Varieties of Flower Seeds	Seed Exchange	-	$2.00
2	Car loads of Broken Concrete	Alves Inc.	-	-
2	Bucket of Paint	Ace Hardware	$30.00	$71.98
9	Six-pack of Vegetable Starts	Pierson's Garden Store	-	$18.00
1	Mini Shed	Ace Hardware	$150.00	$150.00
1	Hose	Lonny Grafman	-	$12.99
2	Paint Brushes	Walgreens	$8.00	$8.00
Total Cost			**$198.00**	**$305.65**
Total Savings			**$107.65**	

Figure 5.1: This is the cost of all the materials we spent.

5.3.2 Time spent

A majority of our time was spent on physically working in the garden. There were some tedious tasks that took a lot of time to finish, such as pulling up the tarp, but spending hours of working in the garden made us progress further to our final project goal. The total amount of time spent on this project was around 173 hours. About 90 of those hours were spent just working in the garden. Figure 5.2 shows in more detail how much time was spent on each section.

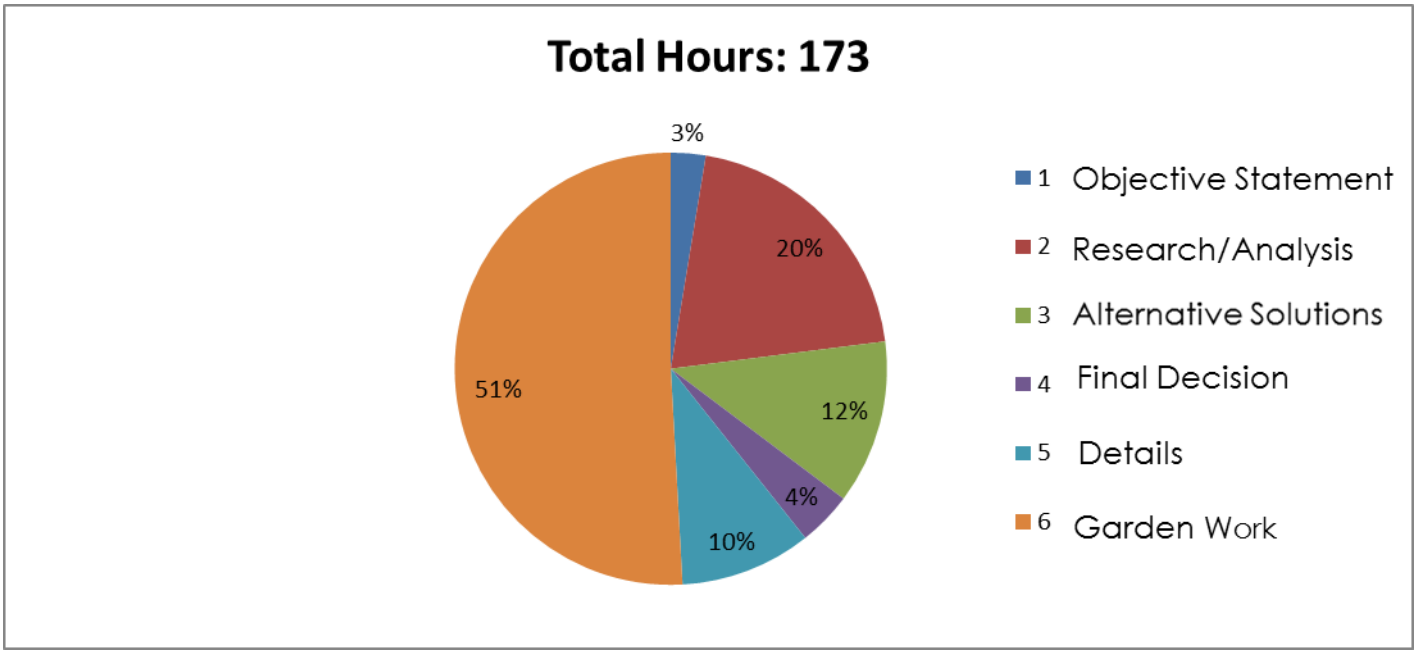

Figure 5.2: The hours spent on individual sections as well as physical work in the garden.

5.3.3 Maintenance Cost

The maintenance cost mainly for this garden is the time that will be spent on watering it. The After School Program as well as the Special Education Program are excited to start working in the garden. They will keep it alive and growing after we leave at the end of the year. Figure 5.3 shows the estimated amount of time that the garden will require throughout the year.

Maintenance	Time (estimate)
Watering (in dry seasons)	1 hour/week (on average)
Watering (in wet seasons)	0
Weeding	5-30 minutes/week
Harvesting	30 minutes/week
Seasonal Turn-over	1-3 hours 2x/year

Figure 5.3: The total hours that are projected it will take to maintain the garden.

5.4 Results

The newly updated garden at Zane Middle School is ready to be taken care of and loved by the students and staff. Throughout this process of removing landscaping fabric, planting and painting the planters, cleaning the memorial site, and finding a new way of storing the tools much has been learned. There is not a solid plan in place that will lead to the success of this garden. With curriculum also in place the teachers are equipped with the tools that are needed for the garden to succeed. The updated garden was much needed and now that Zane has to tools to keep it going they will have a long and successful garden.

6 Appendix

6.1 Bibliography

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