COMPUTER PROGRAM PROTOTYPE FOR DIAGNOSIS OF WATER QUALITY RELATED DISEASES OF GOLDFISH (*Carassius auratus*) IN AQUARIUM

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The objective of this study was to develop a computer program prototype for diagnosis of water quality related to diseases of goldfish in aquarium. Information concerning diagnosis of such diseases, i.e. symptoms, disorder behavior, water quality, medication and suitable environment, was collected and electronically stored.

The program was developed using a top-down model, which is quite suitable well for developing a small software. Information relevant to the program was collected from both primary and secondary sources. They were obtained from interviewing experts in the field, as well as reviewing scientific literatures, journals and internet. These data was recorded into database tables designed by Paradox 7.0. For coding condition sentences 'If_then_else and select_case', Borland Delphi 6.0 were employed. Prior to the actual process of program development, program flowcharts were prepared. This was conducted, in order to improve understanding of the task and to ease program implementation. For preparation of user interface, the Graphic User Interface (GUI) was applied. Accordingly, for this study three different interaction styles, which were menu selection, form fill-in and direct manipulation, were chosen relative to information required for display. Four information display screens included 'Detail, Diagnosis, Result and User Help' were designed. Accuracy of the developed program was evaluated by interviewing fish disease experts on the program. Students from the Faculty of Fisheries, Kasetsart University, were chosen for testing user friendliness of the program. The results were statistically analyzed and recommendation for further studies was concluded.

The results indicate that the developed program enabled users, who were unfamiliar with fish diseases, to properly diagnose water quality related diseases of goldfish in aquarium by themselves. In addition, the program provides valuable knowledge relating to goldfish, care and illness prevention. However, a few improvements on the program could be made. These include adjusting program compatibility to an 800*600 pixels screen and addition of image and movies of water quality related diseases of goldfish in aquarium. For further studies, programs should be designed so that flexibility in terms of program editions and information additions can be achieved.

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ธีรศักดิ์ มาตาเดิม : โปรแกรมคอมพิวเตอร์ต้นแบบ เพื่อใช้ในการวินิจฉัยโรคของปลาทอง (*Carassius auratus*) ที่เกี่ยวข้องกับคุณภาพน้ำในตู้เลี้ยง (COMPUTER PROGRAM PROTOTYPE FOR DIAGNOSIS OF WATER QUALITY RELATED DISEASES OF GOLDFISH (*Carassius auratus*) IN AQUARIUM.) คณะกรรมการควบคุมวิทยานิพนธ์ : พัฒน ทวีโภค, Ph.D., นันทริกา ชันซื่อ, DVM., MBA., Ph.D., อัจฉราพร สังข์เพ็ชร, Ph.D., 97 p. ISBN 974-04-2641-7.

การศึกษาครั้งนี้มีวัตถุประสงค์ เพื่อพัฒนาโปรแกรมคอมพิวเตอร์ต้นแบบ เพื่อนำไปใช้ในการวินิจฉัยโรคของปลาทองที่เกี่ยวข้องกับคุณภาพน้ำในตู้เลี้ยง และ เพื่อทำการเก็บรวบรวมองค์ความรู้เกี่ยวกับการวินิจฉัยโรคดังกล่าว เช่น อาการ พฤติกรรมที่ผิดปกติ และ คุณภาพน้ำ เป็นต้น

โปรแกรมที่ศึกษาในครั้งนี้มีรูปแบบการพัฒนาแบบ top - down model ซึ่งเป็นรูปแบบที่เหมาะสำหรับการพัฒนาโปรแกรมขนาดเล็ก ส่วนข้อมูลที่ใช้ในการพัฒนาโปรแกรมจะมีการเก็บรวบรวมทั้งข้อมูลปฐมภูมิ ที่ได้จากการสอบถามจากผู้เชี่ยวชาญ และ ผู้มีประสบการณ์ด้านโรคปลา และ ข้อมูลทุติยภูมิที่ได้จากการเก็บรวบรวมจากเอกสารวิชาการ วารสาร และ อินเตอร์เน็ท จากนั้นทำการเก็บข้อมูลที่รวบรวมได้บันทึกลงในตารางที่ออกแบบโดยใช้โปรแกรม Paradox 7.0 ส่วนขั้นตอนการเขียนโปรแกรม ใช้โปรแกรม Borland Delphi 6.0 ในการเขียนประโยคเงื่อนไข If_then_else และ Select_case โดยมีการเขียนผังลำดับขั้นตอนการทำงานของโปรแกรม (Flowchart) ก่อน ที่จะทำการเขียนโปรแกรมเพื่อให้ง่ายต่อการเข้าใจ และ เขียนโปรแกรม ในการออกแบบส่วนติดต่อกับผู้ใช้นั้นใช้เทคนิค Graphic User Interface (GUI) โดยในการศึกษาครั้งนี้ได้เลือกใช้รูปแบบในการแสดงผลข้อมูล 3 ลักษณะ คือ menu selection, form fill-in และ direct manipulation ตามความเหมาะสมของข้อมูลที่ต้องการแสดง ซึ่งรูปแบบของการแสดงผลข้อมูลสามารถแบ่งออกเป็น 4 หมวดหมู่ คือ หมวดรายละเอียด การวินิจฉัย การรายงานผล และ ส่วนช่วยเหลือผู้ใช้ หลังจากพัฒนาโปรแกรมเรียบร้อยได้ทำการทดสอบความถูกต้องของระบบโดยสัมภาษณ์ความเห็นของผู้เชี่ยวชาญด้านโรคสัตว์น้ำ และ ทดสอบความพอใจของผู้ใช้ที่มีต่อส่วนติดต่อกับผู้ใช้ โดยทดสอบกับนักศึกษาคณะประมง มหาวิทยาลัยเกษตรศาสตร์ เพื่อนำข้อมูลที่ได้จากการสัมภาษณ์และ ทดสอบมาประมวลผลทางสถิติ แล้วทำการสรุปผลการศึกษา เพื่อเป็นแนวทางในการศึกษาครั้งต่อไป

จากผลการศึกษา พบว่า โปรแกรมที่พัฒนาขึ้นสามารถช่วยให้ผู้ที่ไม่มีความรู้เกี่ยวกับโรคปลาสามารถทำการวินิจฉัยโรคของปลาทองที่เกี่ยวกับคุณภาพน้ำในตู้เลี้ยงได้ด้วยตนเอง และยังให้ความรู้เกี่ยวกับปลาทอง การดูแล และ การป้องกันโรค เพิ่มขึ้นอีกด้วย แต่โปรแกรมจะมีความสมบูรณ์มากขึ้น ถ้ามีการปรับปรุงโปรแกรมให้สามารถใช้ได้กับ screen area 800*600 pixels และ มีการเพิ่มรูป และ ภาพเคลื่อนไหวเกี่ยวกับอาการโรค เพื่อให้ผู้ใช้เข้าใจปัญหา และอาการได้ง่ายขึ้น นอกจากนั้นในการพัฒนาโปรแกรมต่อไปในอนาคต ควรออกแบบให้โปรแกรมมีความยืดหยุ่น สะดวกในการปรับแก้ไข และเพิ่มเติมข้อมูล

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CHAPTER I
INTRODUCTION

1.1. Background and Rational

Goldfish, *Carassius auratus,* is one of the most popular pets in the world (1). Their popularity is due to its brilliant metallic gold and reddish color. Naturally, Goldfish occur in China. However, Japanese are the first who bred and improve it to today's appearance (1,2). Through continual selective breeding, its different forms and colors have been established. There are many new varieties such as Celestial, which has telescopic eyes situated on top of its head: Bubble Eye, which has eyes similar to large sacs: Red Cap Oranda, which has a metallic gold body and a lumpy head. It took some years before these fancy goldfish reached Eastern Europe in the 18th century and America in the 19th century. Goldfish reached Thailand between 1691 and 1692 of Ayutthaya period (1,2). Since then, goldfish has become one of the most favorite aquarium fish in Thailand (3). They can adapt rapidly to a new environment and can be easily cultured and bred. They are kept in marble basins, aquarium and decorative fountains in many homes and gardens. Keeping goldfish as a hobby is believed to induce the keepers with a sense of cherishing the natural environment. Therefore, this hobby should be promoted because it will enhance natural reservation behavior among people.

The goldfish businesses can provide many local employment opportunities. During the economic crisis, numbers of the unemployed and laid off laborers have greatly increased in Thailand (3). In order to survive during the economic difficulty, many of them escaped from cities and returned to their hometown in rural areas. Some of those laborers have been employed in many goldfish hatcheries, which were located in the central part of Thailand such as in Ratchaburi, Suphanburi and Angthong (3). Goldfish hatchery business requires usually low investment, uses small area and takes relatively a short time for return of its investment. In 1998, The Department of Fisheries has established the Aquaculture of Ornamental Fish Program

aiming at providing employment opportunities and income source for fish breeders. This program was also planned to reduce the migration of rural labors to urban areas (3).

In 1997, there were 657 aquarists in Thailand who produced 107.2 million ornamental fishes (4). Goldfish accounted for 57.14% of these total productions. They were bred mostly to supply the domestic demand. The major market for goldfish is the Sunday market in Bangkok. The popular varieties are such as the common goldfish, Shubunkins and Comet (4). Their prices range from low to moderate price depending on their color and figure quality. The amount of exported goldfish was relatively small and most of them were of low quality and usually used as baits (1). Because of high quality standard required by international market, Thai exporters could not compete commercially with the exporters from Malaysia, Singapore and Japan (5). In addition, broodstock goldfish is quite expensive because it has to be imported from abroad (6). To solve this problem, the Department of Fisheries has organized several goldfish competitions to promote the selection of good characteristic in male and female goldfish for breeding programs. As a result, goldfishes that meet the international standards are easier to obtain which in turn decreased the cost and amount of imported goldfish (5).

Keeping goldfish in good health is the best way to prevent them from contacting disease (6). If goldfish become ill, most of the aquarists would probably agree that those fishes have been attacked by pathogenic organisms such as bacteria, fungi and viruses. These organisms sometimes remain dormant (inactive) and cause no appreciable adverse effect to fish. However, when goldfish are in an unsuitable living environment, they become weak and can easily be infected. Observation goldfish behavior: disorder symptoms, as well as their biology, such as symbiosis between fish and parasites. and chemical factors, including water quality could be advantageous for preventing disease outbreaks. When aquarists keep goldfish in a suitable environment, they are most likely to remain healthy.

However, many aquarists lack knowledge relating to water quality related diseases of goldfish in aquariums (6). This knowledge is usually limited to fishery biologists, veterinarians, and fish health experts. Information concerning fish diseases are everywhere. Therefore, it is difficult for aquarists to search for documents on diagnosis and treatment of water quality related diseases of goldfish in aquariums by themselves. If appropriate knowledge on these topics is more easily accessible, time and cost for the treatment could be significantly reduced.

For diagnosis of water quality related diseases of goldfish in aquarium, fish health experts are very important. However, they often work in cities and are not always readily available for solving problems for the aquarists in need. It is also difficult to transport sick goldfish to them. Thus, fundamental methods for diagnosis and treatment of water quality related diseases of goldfish in aquariums should be widely distributed.

A computer program can be utilized for this purpose. Knowledge and experience on diagnosis and treatment of water quality related diseases of goldfish in aquariums from textbooks, internet, related research, journals, as well as interviewing experts can be complied into a database for developing a computer program prototype for diagnosis of water quality related diseases of goldfish in aquarium.

1.2. Objective

1.2.1. To develop a computer program prototype for diagnosis of water quality related diseases of goldfish in aquariums.

1.2.2. To collect related information concerning diagnosis of water quality related diseases of goldfish in aquariums such as symptom, disorder behavior, water quality, medication and suitable environment.

1.3. Scope of Research

1.3.1. To develop a computer program for diagnosis of water quality related diseases of goldfish in aquarium that can be observed from disorder behavior and abnormal symptoms, excluding diseases that need diagnosis in laboratory by technician.

1.3.2. Fish health experts and students who have knowledge and experience on water quality related diseases of goldfish in aquariums were selected as program testers.

1.4. Expected Benefits

1.4.1. To assists aquarists and hobbyists on diagnosis of water quality related diseases of goldfish in aquariums.

1.4.2. To provide aquarists and hobbyists with information relating to water quality related diseases of goldfish in aquariums.

1.4.3. Aquarists, who lack of knowledge relating to water quality related diseases of goldfish in aquarium, can solve this problem by themselves.

1.4.4. This program is a prototype fundamentally for further development of a computer program relating to water quality related diseases of goldfish in aquarium.

CHAPTER II
LITEATURE REVIEW

This study was for development of computer program for solving problems concerning to water quality related diseases of goldfish in aquarium. Therefore, the necessary information will have to be collected to implement computer program as follows:

2.1. Goldfish

2.1.1. Classification

The wild ancestor of domestic goldfish species is the carp species *Carassius auratus*. The goldfish species are closely related to the crucian carp (*Carassius carassius*) (7).

The goldfish can be classified as follow (8):

Thai Name	:	Pla Thong
English Name	:	Goldfish
Scientific Name	:	*Carassius auratus*
Kingdom	:	Animal
Phylum	:	Chordata
Subphylum	:	Vertebrata
Superclass	:	Gnathostomata
Class	:	Actinopterygii
Division	:	Teleostei

2.1.2. Varieties

The goldfish has been developed into more than 125 varieties (9). Among the most popular varieties, common goldfish, shubunkins, and comets, have a wide range of price from very inexpensive to moderately priced depending on their quality (10).

Therefore, this research describes those varieties that are most commonly available and relatively easy to care for which are as follows:

1. Comet

They have a single dorsal fin and a very sleek body. Comet can swim very fast for short periods of time. This is the best kind of goldfish for the beginning hobbyist due to its hardy character (11). The comet is illustrated in Figure 2-1.

Figure 2-1 Comet

2. Shubunkin

The Shubunkin almost always has a speckled or variegated color pattern. It is often referred to as blue background with patches of violet, red. orange, yellow and brown, spotted with black. The Shubunkin is a smaller fish. The minimum length of shubunkin body is 7.5 centimeters (12). The caudal fin is moderately forked and has wide, well - rounded lobes. The Shubunkin is recommended for beginners. The shubunkin is illustrated in Figure 2-2.

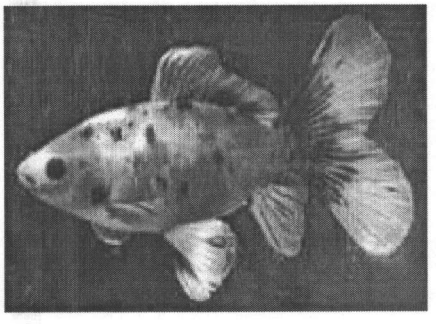


Figure 2-2 Shubunkin

3. Common Goldfish

The Common goldfish, being closely related to the original stock, has most of its characteristics. It is very hardy, and can withstand extremes of temperatures. The common goldfish will eat almost any food. It is easily tamed and is a prolific breeder. The body is rather long and flattened on the sides. The head is short, wide and without scales. The dorsal fin, the caudal fin and the anal fin are all single in the common goldfish. The Pectoral fins and ventral are paired (13). The common goldfish is illustrated in Figure 2-3.

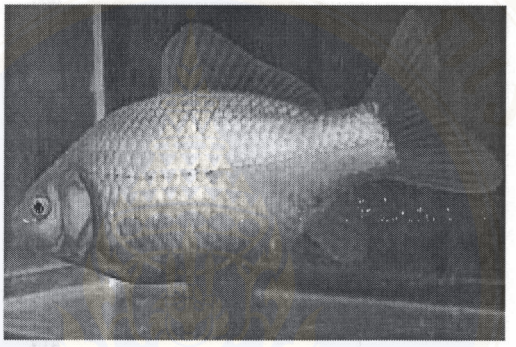


Figure 2-3 Common Goldfish

4. Fantail

The main distinguishing feature of this variety is split or double caudal fin, which is of moderate length and slightly forked. There is a commonly available Japanese version of the fantail called the Ryukin. It has an extremely high curved dorsal fin, which seems almost discontinuous from the rounded egg-shaped body. Both fantails and ryukins grow to about 15 centimeters: including the tail. Both are recommended for the beginner (9). The fantail is illustrated in Figure 2-4.

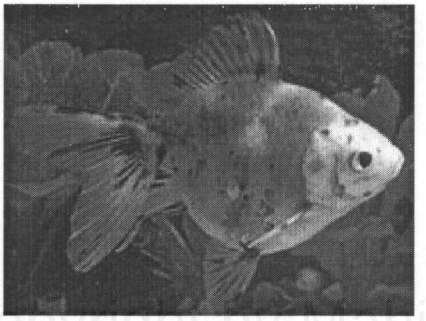


Figure 2-4 Fantail

5. Pearl Scale

Pearl scale mutates from fantail. They are usually twin tailed and have quite a compact body (14). The scales appear like half pearls or hemisphere. The color range is both metallic and nacreous. The pearl scale unsuitable for outdoor ponds, and lower temperature aquariums. The pearl scale is illustrated in Figure 2-5.

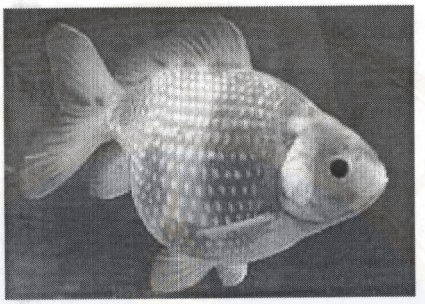


Figure 2-5 Pearl Scale

6. Pom Pon

The feature of the Pom Pon is the excessive development of the nasal septa, the nostrils of goldfish. The pom pon may have full finnage or no dorsal fin: the body is of the short egg-shape type. All colors and scale types available. The bouquets are sometimes no bigger than the normal eyes of fish but sometimes they are as large as one-third of the size of the head. In most specimens, the bouquets float in front of the eyes when the fish is swimming, but in some specimens, more grotesquely, they are sucked into the mouth every time that the fish draws in water (15). The pom pon is illustrated in Figure 2-6.

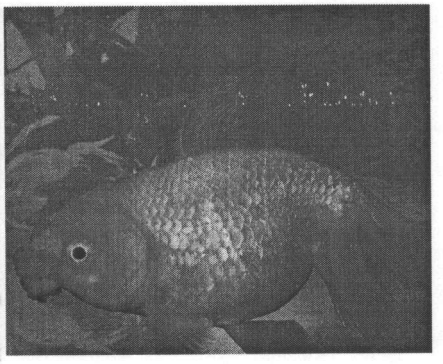


Figure 2-6 Pom Pon

7. Veiltail

This fish was derived from the Japanese Wakin, a double-tailed goldfish with an elongated body like a common goldfish. The veiltail looks a lot like a fantail, except that it has extremely long delicate looking fins. The dorsal fin, while long, is usually held erect, and it has an extremely convex outer edge. The double caudal and anal fins are well separated. Its body is a bit rounder than a fantail and accordingly, its swim bladder is a bit more distorted. It usually grows to about 15 to 18 centimeters, of which 7.5 to 10 centimeters comprise the tail.

Its delicate fins are very subject to injury, subsequent fungal and bacterial infections. Its extremely distorted swim bladder is very sensitive to chill. The veiltail should be kept only with other veiltail or other extremely noncompetitive varieties. It improper fish for beginners (9). The veiltail is illustrated in Figure 2-7.

Figure 2-7 Veiltail

8. Telescope

This is indeed an unusual fish. It has large eyes mounted on the ends of telescopelike or conelike stalks. In an adult specimen its eyes can be as far away from its head as 19 or 20 millimeters.

Except for the eyes and its slightly smaller size. It is available in metallic and nacreous-scaled. It usually reaches a length of only 10 centimeters. Its biggest problem is that it does not see very well and thus it is not a good competitive for food. So, telescope should be kept only with less competitive fish.

The telescope should be kept only by experienced fishkeepers. Even thought it is not weak, the short-finned telescope is not recommended for beginners (9). The telescope is illustrated in Figure 2-8.

Figure 2-8 Telescope

9. Moor

The moor is basically a black version of the telescope. It is known in England as the blackmoor. In a good specimen its color is a velvet jet black. One of the surprising things about the moor, despite its telescope eyes, which are subject to injury and infection, is its hardiness. It has a high tolerance for low temperatures. In fact, it is recommended for beginners if it is not kept with highly competitive fish. Indeed, it even does well in a small fishbowl. However it can be kept in outdoor pond (9). The Moor is illustrated in Figure 2-9.

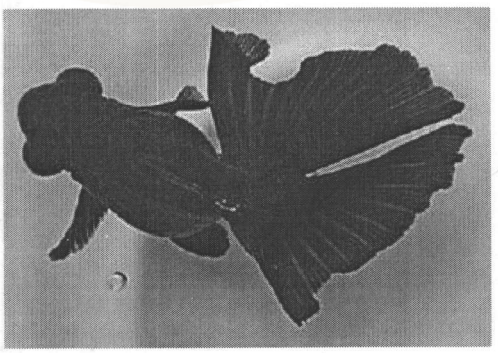


Figure 2-9 Moor

10. Oranda

In Japan this fish is known as Oranda Shishigashiri. The oranda is very similar however the significant difference is the top and somewhat on the sides of the head of oranda that have the fleshy growth. The fleshy growth is called hood. It is subject to infect from virus, bacteria and fungi. The oranda is seen mostly in the metallic-scaled type, yellow to a rich cherry red, all with the typical metallic gleam.

Unfortunately oranda is as delicate as any veiltail and should be kept only by experienced fishkeepers (9). The oranda is illustrated in Figure 2-10.

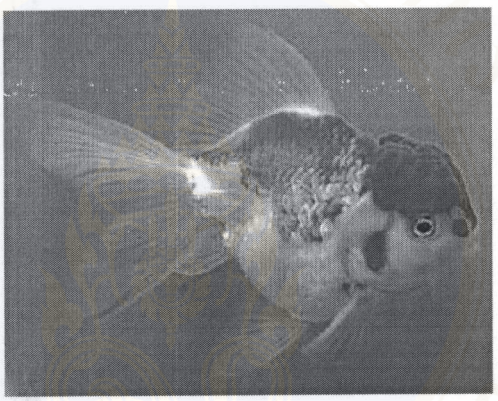


Figure 2-10 Oranda

11. Lionhead

The lionhead is one of those cumbersome fish that lacks a stabilizing mess hall. Nevertheless, a good specimen kept with other slow-moving varieties can get enough chow to thrive quite well. The maximum length of lionhead body to be 12 or 13 centimeters, and has short fins with a double caudal and anal fin.

The broad head of lionhead (except for its mouth, nostrils, and eyes) is completely covered by a fleshy growth. Just remember that the lionhead is a very delicate fish and should be handled accordingly. It is not recommended for beginners (9). The lionhead is illustrated in Figure 2-11.

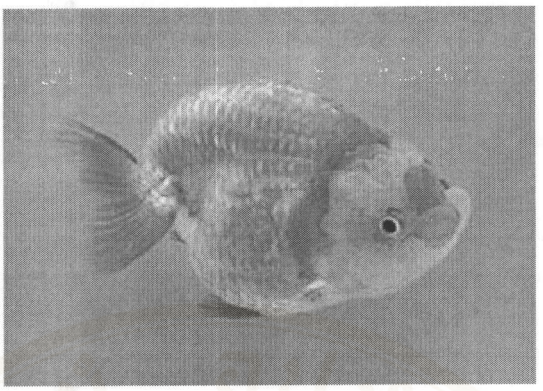


Figure 2-11 Lionhead

12. Celestial

The celestial is a name for its bulging eyes that stare up-ward. Thus the Chinese as the stargazer knows it. In Japan it is known as the Deme-ranchu. The size, general form, and delicateness of celestial is very similar to the lionhead. Most often it is seen in the metallic-scaled form. Celestial is not recommended for beginners (9). The celestial is illustrated in Figure 2-12.

Figure 2-12 Celestial

13. Bubble Eye

Here is a goldfish that can only be described as bizarre. It is dorsalless, double-tailed,and quite similar in size and shape to the celestial. Its eyes are also turned upward but not as severely.

The bubble eye is two years old, the eye sacs are huge and look like two balloons being dragged around in the water by a fish. When the eye sacs develop completely, it is almost impossible for bubble eyes to see anything and it can barely even swim. Bubble eye can be infected easily by microorganism due to the eye sacs break easily but heal slowly. For obvious reasons bubble eye is not recommended for community aquariums or for beginners (9). The bubble eye is illustrated in Figure 2-13.

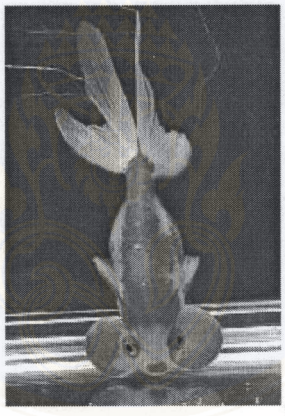
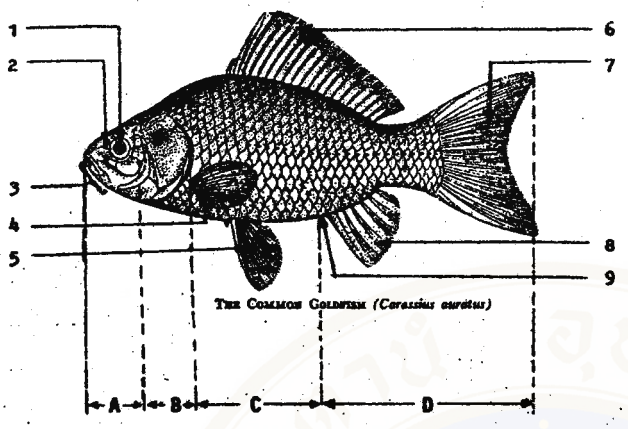


Figure 2-13 Bubble Eye

2.1.3. Morphology

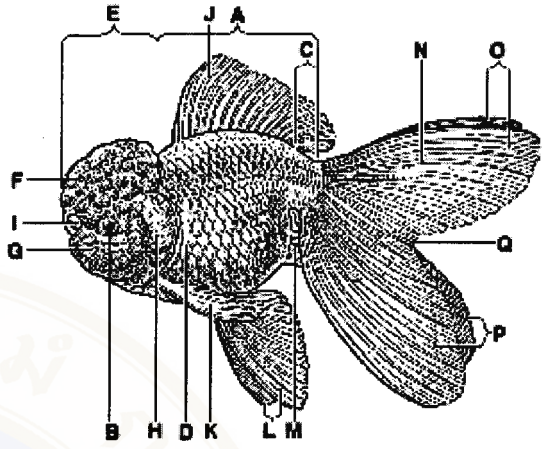
Wild goldfish length is 30 to 40 centimeters, excluding the caudal, tail, or fins: they rarely attain a length of 45 centimeters. Their weight ranges from 0.2 to 1.0 kilograms. Their body has 2 forms: elongated compress and egg-shaped or rounded. Goldfish have four pharyngeal teeth on each of the bilateral pharyngeal bones and 39 to 50 gill rakers (7). The goldfish anatomies are illustrated in Figure 2-14.

Elongate compressed bodies (16)



A : Mouth Region
B : Gill Region
C : Body Region
D : Tail Region
1 : Eye
2 : Nostril
3 : Lower Jaw
4 : Pectoral Fin
5 : Pelvic or Ventral Fin
6 : Dorsal Fin
7 : Caudal Fin
8 : Anal Fin
9 : Anus

Rounded or Egg-shaped bodies (17)



A : Body
B : Eye
C : Caudal Peduncle
D : Lateral line
E : Head
F : Cranial Region(of head)
G : Sub Orbital Region(of head)
H : Operculum
I : Nasal septum
J : Dorsal Fin
K : Pectoral Fin
L : Pelvic or Ventral Fin
M : Anal Fin
N : Caudal Fin
O : Upper Caudal Lobes
P : Lower Caudal Lobes
Q : Fork

Figure 2-14 The diagram shows goldfish anatomy.

2.2. Requirement of Goldfish

Goldfish is hardy freshwater tropical specie. They can be kept in a variety of habitat, for example, garden pond, indoor tank, however there are frequently held in small bowls or aquarium. In order to make goldfish comfortable to live in aquarium, goldfishkeeper should provide suitable environment for them. Goldfishkeeper must be aware of their environmental needs and requirements that effect to goldfish health. When goldfish live in suitable environment aquarium, goldfish will be healthy and immunize. In opposite way, when goldfish live in unsuitable environment aquarium, the goldfish immunity will be reduced that made goldfish weak and may be attacked by pathogen later. The information relating to suitable environment in aquarium and goldfish requirement will be described as follow:

2.2.1. Water Quality

In general, plain clean water is just fine. Rain water, fresh spring water, or well water are generally better suited than chlorinated or fluoridized tap water. Tap water, which is usually all that is available, must be suitable conditioned for goldfish. Although, goldfish can tolerate a wide range of water parameters, but attention to their needs on a more rigorous set of guidelines will not be detrimental (18). It is essential for steady growth and development that goldfish should get fresh water, which water quality is suitable (Table 2-1).

Table 2-1 Water parameter limits for goldfish (18).

Water Parameter	Optimum Range
Temperature	28 - 32°C
pH	6 - 8.5
Alkalinity	> 2.5 ppm.
Dissolved Oxygen	4 - 10 ppm.
Carbon Dioxide	< 5 ppm.
Hydrogen Sulfide	< 0.3 ppm.
Un - Ionized Ammonia	< 0.01 ppm.
Nitrite	< 0.01 ppm.
Phosphate	< 6.0 ppm.
Potassium	< 2.0 ppm.
Sodium	< 5.0 ppm.

2.2.2. Nutrition

Goldfish require a nutritionally balanced diet in order to ensure that the goldfish remain healthy, grow fast and be in their best possible condition. By this mean that goldfish requires the correct amounts (and quality) of proteins, carbohydrates, fats, minerals and vitamins (19). The relative amounts of each of these nutrients required in the diet vary depending on water temperature, size of fish and maturity (Table 2-2).

Table 2-2 Nutrients required in a balanced diet (19).

Nutrient	Composition	Use in body	Examples
Protein	- Various combinations of 23 amino acids, 13 of which are essential for the goldfish	- Form or repair body issue and for inefficient energy production. - Cannot be stored.	- Live foods.
Carbohydrate	- Generally formed by plants from carbon hydrogen and oxygen	- Energy production. - Excess stored in muscle and liver.	- Sugars, Starch
Fat	- Formed from fatty acids.	- Energy production (+ tissue formation). - Excess stored in fatty deposits and liver.	- Oil, Fats
Minerals	- Chemical ions.	- Regulate body processes.	- on – blood composition. Calcium – bone composition
Vitamins	- Complex compounds formed by plants.	- Regulate physiological processes by forming enzymes.	- Vitamins A, B, C and D.

2.2.3. Space

Basically, the necessary amount of water depends largely on the size the variety of the goldfish, the method of goldfish keeping, and the temperature. The water in which the fish lives serves:

1. As a medium for gas exchange for respiration (oxygen uptake and carbon dioxide release)
2. As the recipient of waste products and to break down and dissolve those substance resulting from biological processes of the goldfish
3. As the medium in which the fish moves and reacts

In general, their relatively small requirements for movement and for oxygen allow goldfish to flourish even in cramped living quarters. However, an effort should be made to improve the quality of the water by aerating the aquarium or by adding aquatic plants, which will, if healthy, assimilate carbon dioxide and produce oxygen.

Insufficient Space may result in:

1. Respiratory insufficient breathing becomes difficult. The fish may be suffocating and try to gasp for more air at the water surface:
2. Increased accumulation of slime and waste deposits as a result. The water becomes murky quickly or, in extreme cases , even foul, and the goldfish are in imminent danger of being poisoned:
3. Lethargy with problems in the organs governing movement and digestion

The space necessary for the optimum care of goldfish depends upon the methods and objectives of the hobbyist (7). The optimum water volume for goldfish requirement and number of goldfish to keep in tank will be shown in Table 2-3 and Table 2-4 respectively.

Table 2-3 Average water volume required per goldfish in liters at a temperature of 18°C - 25°C (7).

Type of System	Length of goldfish(Centimeters)								
	2	3	4	5	6	7	8	9	10
Bowl	1.5	2	3	5	7	8	10	25	35
Non-aerated aquarium	3	4	5	6	8	10	12	16	30
Aerated aquarium	2	3	3.5	4	5	6	7	8	12
Outdoor goldfish breeding	3-4	4-5	7-8	10-11	16-17	30	40	50	70

Note: The water volume required for more delicate varieties (celestials, peacock tails, lionheads, and bubble eyes) with a length of more than 4-5 centimeters is twice the average. For example, 6 centimeters peacock tail kept in a simple bowl needs 14 liters of water: in an aquarium, it needs 10 to 16 liters, depending on the presence of aeration: for backyard breeding, 32 to 34 liters are required.

Table 2-4 Total number of goldfish that may be kept per 1 square meter of surface area in outdoor breeding tanks 30 centimeters deep (7).

goldfish length (Centimeters)	Number of goldfish	
	Hardy varieties	Delicate varieties
0.6	1,500	1,000
1.0	1,000	500
2.0	200	100
3.0	150	50
4.0	100	50
5.0	60	15
6.0	40	8
7.0	30	5
8.0	25	3
9.0	20	2
10.0	15	1

Note: Delicate varieties include lionheads, peacock tails celestials, bubble eyes, and redheads.

In another way, in order to determine how many goldfish an aquarist can safely keep in a container, an aquarist must find the surface area of the container which an aquarist wish to put then in. The following formula works is the top of the aquarium is rectangular (20).

Surface Area = Length x Width $(Inch)^2$

Inches of goldfish = Surface Area / (30 x n)

n = numbers of goldfish that an aquarist want to keep

2.3. Non – Infectious Diseases

Diseases which etiologically do not involve specific causative agents and which are thus not infectious (contagious), can be classified, according to the cause, into four groups: heredity, environment, alimentation and mechanical – traumatic origin. Diseases, which are caused by heredity, general anatomical or functional deficiencies and malformations, which deviate from the normal, are designated as hereditary diseases hereditary defects. In contrast to these, there are diseases that are caused purely by the environment, thus for instance, by injuries, poisoning or nutritional defects that can therefore be designated as environmental disease (21).

There are several other diseases which may develop due to quite harmful effects of environment or of parasites in the wider sense, in other words due to exogenic causes of diseases: in spite of this, endogenic factors, namely the genotypes, play a part at the same time. These are designated as hereditary environmental diseases.

Toxin in water due to pollution, toxigenic foods or toxic components in fish diet causing fish poisoning, are very important at present in connection with purely environmental diseases. The increasingly extensive application of pesticides and herbicides, the large number of new toxic substances in waste waters (22).

The non – infectious diseases can be divided into 3 cause as follows (23):

1. Diseases due to environmental stress: Thermal, Oxygen, Carbon Dioxide, Gas – Bubble Disease, pH, Light, Electricity and Poisoning
2. Diseases due to nutritional imbalance: Vitamin, Protein, Lipoid, Mineral and Starvation
3. Other: injuries, genetic, radiation and so on

As stated earlier, there are several factors that will affect the uptake of heavy metals into organism. It is important to know if the metal appears as a free ion or as an inorganic complex or bound to particulate matter in the water. The form in which the metals occur is dependent on the water chemistry such as pH, salinity and temperature as well as on the presence of complexing agents and organic matter in the water (24). A list of environment factors and their general effects on the specialization of heavy metals are given (Table 2-5).

Table 2-5 Environmental factors and their general effect on the specialization and uptake of heavy metals (24).

Environmental Variable	Modulating Factor	Effects
Temperature	Metabolic rate oxygen consumption	- An increased respiration rate leads to increased uptake
Water Hardness	Ca^{2+} , CO^{3-}	- Ca^{2+} is an antagonist to Cd^{2+} and Zn2+ by its competition for Ca sites in pores and pumps carbonate forms complexes with heavy metals - Result in deceased uptake
pH	H^{+} , OH^{-}	- Low pH leads to increased H^{+} and free metal ion concentration. - High pH leads to metal – hydroxyl formation.
Organic Compounds	Humic Substances	- Complexation and decreased uptake
Complexing Agents	E.g. EDTA, NTA	- Complexation and decrease uptake
	E.g. Xanthates	- Increased lipophilicity and uptake
Salinity	Cl^{-}	- Increased formation of metal – chlorides and a decrease in uptake

The only way in which metals can be eliminated from the body is by excretion. The metals may be excreted through the gills, skin, intestine, live, gall bladder o kidney. Since heavy metals are indestructible, an organism cannot protect it self from the toxic effects by metabolic degradation. There are three ways in which organisms can protect it. First it may decrease the rate of uptake of heavy metals: second it may bind the metals to organs and hence keep the metals from disrupting normal physiological processes: and third it may excrete the metals (24).

Some reports have indicated that cataracts and other eye disorders may have a genetic basis. This may be an exception, as the majority of eye disorders appear to be nutritionally derived or pathogenically (24) (Table 2-6).

Table 2-6 Nutritional deficiencies leading to eye disorders nutritional.

Nutritional	Disorders
Vitamin A	- Exophthalmia, Retinal and Corneal degeneration, Clouding of the Cornea
Thiamin	- Clouding of the Cornea
Riboflavin	- Degeneration of Both the Cornea and the Lens
Sulphur – containing	- Lenticular Opacity with no Involvement of Other Ocular Tissues

2.4. General Diagnosis

When mortality of fish occurs due to adverse environmental effects, almost all fish of quite different species die in a short time. However, deterioration in water also often acts specifically on one (or a few) fish species or age groups (for instance, a change in the pH value, a decrease in the oxygen content, waste waters containing chlorine, etc.) (21).

2.4.1. Ascertaining the Past History

Information on the past history of a disease is very important for a reliable diagnosis of the disease. In each case, the following points must therefore be clarified before taking up the investigation of a disease:

1. Source of fish: river, pond, fish farm, aquarium, breeding stock and other culture management
2. Maintenance of fishes: population density, feeding, water quality, fertilizing, prophylactic and therapeutic treatments, chemicals and drugs used.
3. Observations on condition: disease symptoms, behavior, damage and its development
4. Progress of the disease: fist observations, period of the most server illnesses, earlier observations, eventual causes

2.4.2. Investigations on Quality of Water

Considering the great influence of environmental conditions on fish, investigations on the quality of water are extremely important for ascertaining the causes for their mortality. These constitute one of the initial measures in the complex of elucidation of the causes for the death of fish. The requisite authorities in charge of water supply, hygiene and fisheries should simultaneously notify when there is a threat of unauthorized water pollution. In all such cases, sample of water should be taken with the utmost urgency for investigation on the spot, or at a competent laboratory or dispatched for special water analysis.

2.4.3. Dispatching Diseased Fish

If an investigation of diseased fish by a specialist is not possible either on the spot or in the immediate vicinity, the fish should be dispatched together with the sample of water and a brief report on the previous history to a competent laboratory of fish pathology or toxicology.

2.4.4. Observations on Diseased Live Fish

Investigations on diseased fish must begin when they are still alive. All the changes (body deformations, dislocation, abdominal swelling, injury to the fins etc.) should be closely observed. Pathological changes in individual or observing fish in aquaria, ponds, hatcheries, fish farms and reservoirs can often make out several fish fairly well. Besides the discoloration, signs concerning the behavior of fish must be especially watched in this context. The feeding condition, position of body in water, nature of locomotion are often indicate characteristic symptoms of fish diseases or injuries and they could facilitate the diagnosis.

2.4.5. Determining the Condition of Fatness

Fish with a good condition of fatness have a well-developed dorsal muscular system, with a curvature bulging outward (convex). On the sides, the ribs are not at all (or only faintly) visible. The size of the fins and of the head is relatively small compared with that of the body.

Fish with poor condition have a poorly developed dorsal musculature, which caves in (concave) behind the head. The causes for the poor condition of fitness can be inadequate conditions of feeding, continuous starvation over a long period, chronic oxygen deficiency, chronic intoxication (for instance, ammonia poisoning), chronic infectious disease.

2.5. Treatment and Medication

There are such treatment as oral administration, medicated bath, external applications, injections and operations (25).

2.5.1. Oral Route

The application of medicines mixed with the food is most interesting when fish suffer from nutrition, lesion and internal infection. Medicine can be dissolved in a bit of vegetable or cod-liver oil or gelatin and mixed with fish food. Every piece of food should be surrounded or soaked by the medicine. We can also soak live bloodworms in a concentrated solution. When the worms have absorbed enough of the medicine, they will get listless and move slowly. At that moment, take them out of the solution, wash them, and feed them to the fishes. This technique is used for Levamisole and Niclosamide. Food that contains some medicine must be fed 5 to 7 days, 2 or 3 times a day, without giving any other kind of food (21).

2.5.2. Medicated Bath

Bath treatments have been successful, but so far mostly for tropical aquarium fishes and giving antiparasitic treatment. The following distinctions should be made in connection with antiparasitic treatments:

1. Dip bath: In which the fish are dipped or immersed only for a few seconds (5 – 15 second) in the medium. This has the advantage of handling large numbers of fish in a short time. Of course, special containers are required for carrying out this treatment.

2. Short bath: This is given for 10 – 30 minutes. It is widely used in therapy, since in this time it is often possible to kill the parasites within a few minutes during transport (transport bath). Just as with the dip bath, the duration of the bath must be very precisely adhered to.

3. A prolonged bath may last for many hours to days. It is therefore possible only when the therapeutic index of drugs is large.

So the measurement of quantity of medicines is necessary due to overdose of medicine would have adverse effects on the fish (21).

2.5.3. Injections

Injection of sulfa drugs and antibiotic substance is given to fish affected by bacterial diseases. There are injections both into the muscle and the abdomen. The intramuscular injection is done under the pectoral fins or behind the anus. In the case of hole disease, the injection is given into the affected part after the ulcer is removed. The intravenous injection is done at the tail vein (21).

2.5.4. Operations

Diseased fish are operated under anesthesia. For example, a tumor of the reproductive organ can be removed by an operation. The operated fish should be kept in Ringer's solution with much calcium for a while (25).

2.6. Principle of Prophylaxis

Prophylaxis refers to guarding the health of the fish from the danger of diseases. The prophylaxis is divide 3 lines of defense that detail as follows (26):

2.6.1. The First Line of Defense: Protection

Protection is intended to intercept the pathogen, to cut its pathways to the fish. The protection requires manipulation of the environment in fish habitat. Both abiotic and biotic environments or subject to manipulation. The protection have 10 activities, are as follows: provision of pathogen free water, provision of pathogen free food, hygiene (disinfection of habitat, equipment and fish), control of wild fish, vector and pest control, transplant regulation, quarantine, regular prophylactic treatment, surveys, independent water supply and age segregation (26).

2.6.2. The Second Line of Defense: Prevention

Prevention referred to the need for building up the strength of the fish, and its resistance to pathogens. A pathogen entering a resistant fish will be prevented from developing in it normally. The array of prevention having 6 elements are as follows: water, food, population density, stress avoidance, immunization and genetic manipulation (26).

2.6.3. The Third Line of Defuse: Immunoprophylaxis

Immunoprophalxis affords protection to the organism against pathogens (virus ,bacteria ,parasites) or their tonic products of metabolism , by active or passive immunization. In active immunization and vaccination, the pathogens or their toxins are introduced in a form which is harmless so that the organism actively develops immunity, i.e., antibodies production. In passive immunization (passive protective inculcation, immune or antiserum treatment, immunotherapy), antibody formation takes place in a foreign homologous or heterlogous individual and the preformed antibodies are then introduced. The result of passive immunization is an immediate onset of the protective action, whereas the antibody formation in connection with active immunization requires some time and can therefore be carried out only as a prophylaxis active measure. Simultaneous inoculation implies active and passive immunization employed at the sometime (21).

2.7. Application Program Development

Program was considered increasingly successful if it can executed quickly and gave an acceptable answer (27).

Software development was aimed primarily at getting a single specialized program to work (28).

2.7.1. Software Engineering Environment

Software Engineering Environment is the process, methods and automation required producing a software system (29). A software engineering environment can be depicted as consisting of three individual layers as illustrate in Figure 2-15.

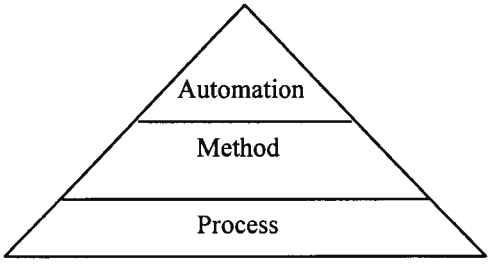


Figure 2-15 Model of software engineering environment

At the bottom is the process of developing software, above which are software engineering method, and finally above that their automation.

The process of developing a software system is the foundation of the environment. Its basic function is to describe the chain of events required to create particular software product. Typically it is a sub-model of much larger model that describes all activities, such as hardware development required to produce the total system.

The methods in a software-engineering environment include all those which are required to define, describe, abstract, modify, refine and document the software product, and are defined by the development process below it in illustration.

The use of the computer to implement the methods necessary to develop the software product in term of automation. A software-engineering environment consists of each of these elements, and the degree to which each layer is integrated with the one above or below it will determine its class and type.

2.7.2. Life Cycle Model

The waterfall or design driven life cycle model is chosen to explain software development process in this research. The waterfall model has major characteristic which the view of software development is proceeding through successive stage called "phases", as illustrated in Figure 2-16 (30).

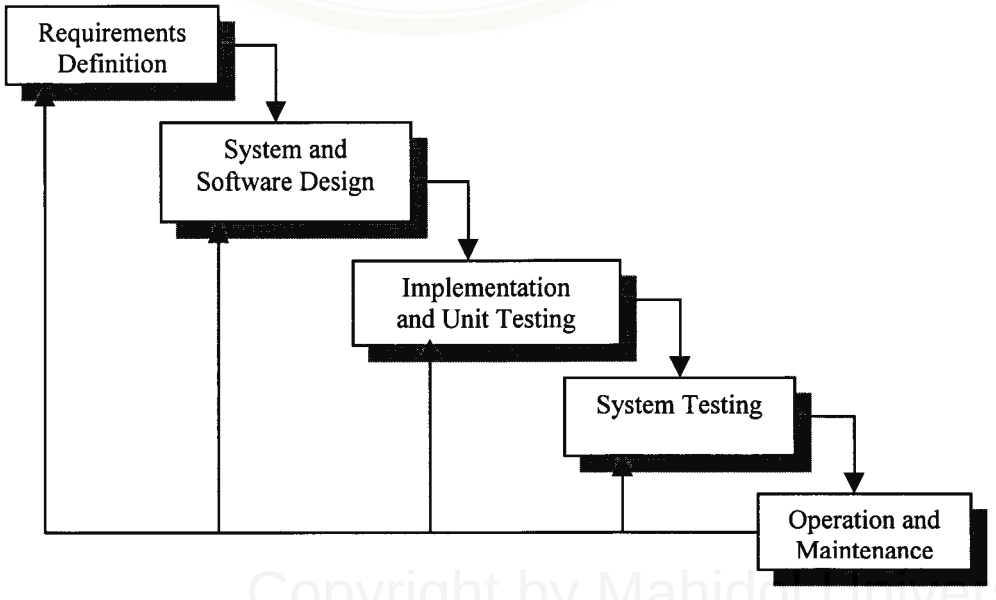


Figure 2-16 The Software Life-Cycle (Waterfall Model)

The phases generally are categorized in the following (31):

1. Requirement Analysis and Definition: The system's services constraints and goals are established by consultation with system users. Once these have been agreed, both users and development staff must define them in a manner, which is understandable.

2. System and Software Design: Using the requirements definition as a base, the requirements is partitioned to either hardware or software systems. This process is termed systems design. Software design is the process of representing the functions of each software system in a manner, which may readily be transformed to one or more computer programs.

3. Implementation and Unit Testing: During this stage, the software design is realized as a set of programs or program units, which are written in some executable programming language. Unit testing involves verifying that each unit meets its specification.

4. System Testing: The individual program units or programs are integrated and tested as a complete system to ensure that the software requirements have been met. After testing, the software system is delivered to the customer.

5. Operation and Maintenance: Normally (although not necessarily) this is the longest life-cycle phase. The system is installed and put into practical use. Maintenance involves correcting errors, which were not discovered in earlier stages of the life cycle, improving the implementation of system units and enhancing the system's services, as new requirements are perceived.

The waterfall model has advantages as follows (32):

1. This model describes intuitively how most feel software development should take place

2. The model does match fairly well to how software is actually developed in practice.

3. Reordering of the steps also proves to be sub-optimal.

The waterfall model has disadvantages as follows (32):

1. Have to define everything before moving on to the next step to make sure nothing is lost or forgotten.

2. The model fails to realistically integrate "activities" that span life cycle phase, such as resource management, quality assurance and other.

The waterfall model works well on small software development projects. Then, the waterfall model is chosen to develop program.

2.8. Well Engineered Software

The well-engineered software is that if the system does what the user wants, it is well engineered. There are 4 attributes which any well-engineered software system should have, those are as follows (28):

1. The software should be maintainable: As long-lifetime software is subject to regular change, it is important that the software is written and documented in such a way that changes can be made without undue costs.

2. The software should be reliable: An appropriate level of reliability is essential if a software system is to be of any use.

3. The software should be efficient: Software system should not make wasteful use of system resources such as memory.

4. The software should offer an appropriate user interface: It is clear that much software is not used to its full potential simply because the interface which it offers makes it difficult to use.

2.9. Relevant Research

Chongmas Srisuwan (33) developed an information system for diagnosis of infectious diseases in chicken. Information relating to symptoms and lesions of infectious diseases in chicken was collected in order to created decision tables. Kasinee Pruetleelar (34) used rule – based technique for developed Toxic Plant Expert System (TPEX). TPEX assisted doctors, pharmacists, nurses and paramedical personnel in diagnosis and treatment of the toxic symptoms of poisonous plant. Chaiwat Hanchanpanit (35) developed an expert system program as a basic diagnosis of visual fatigue for microcomputer users. The tools of program development were

Microsoft Access Version 2.0 (: used for creating the knowledge base) and Microsoft Visual Basic Version 4.0 (: used for creating the inference engine and user interface). Suwimon Kooptiwoot (36) used frame representation for developed a newborn resuscitation expert system. This expert system composed of three parts. The first part was a part of knowledge base represented by frame. The second was a part of inference engine in frame representation. The third was a part of user interface that be would be display in Thai and English. Pichayotai Mahatthanapiwat (37) developed an automobile malfunction diagnosis expert system that comprised of two parts (: the knowledge acquisition and diagnosis). The expert system shell was used by Thawatchai Chankong (38) for developed a blackboard consultation an expert system shell for mechanical system diagnosis due to the expert system shell suitable for creating an expert system that relating to mechanical system. Vinai Sathtachotinun (39) developed the expert system shell with creating factor for mechanical system diagnosis. This system architecture consists of the backward – chaining inference engine with dept – first search and multi – knowledge base link together automatically. Traisuda Waitruardrok (40) developed Sugarcane Variety Identification Expert Systems version 1.0 (CVIX) that can identify 50 sugarcane varieties in Thailand by examining their morphological characters. Computer program for database management of beef farm was developed by Wallop Nakphum (41). This program can help farmers under the project gain more efficient beef production under small farm condition. Computer program for database management of dairy farm was developed by Akasak Rujahkom (42). This program contained tools for operated data such as pull down menu, shortcut key and mouse that make user easy to use computer program.

CHAPTER III
RESEARCH METHODOLOGY

The purpose of this research was to create a computer program for assisting users in diagnosis of water quality related diseases of goldfish in aquarium. The research methodology was divided into 5 steps as illustrated in Figure 3-1.

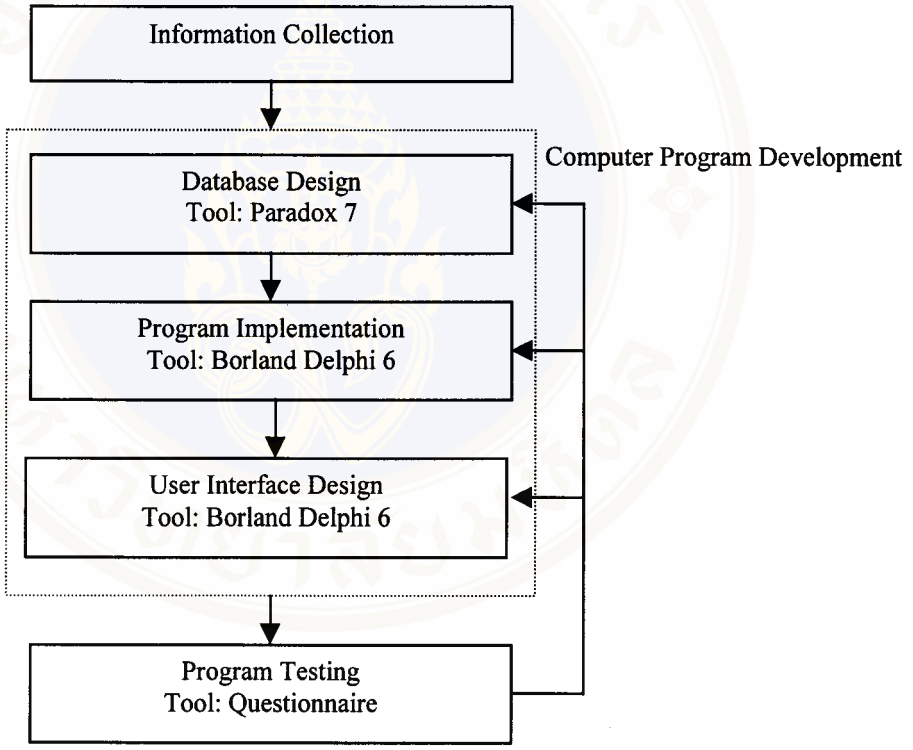


Figure 3-1 Research methodology

3.1. Information Collection

Both primary and secondary information on water quality related diseases of goldfish in aquarium such as diagnosis, treatment and medication were collected. These were obtained from interview, textbooks, journals and the internet (Table 3-1).

Table 3-1 Subjects and sources of related information that were collected for the developed computer program.

Subjects	Knowledge/Information	Sources
Goldfish	- Name - History - Shape - Varieties - Good characteristics - Ecology - Useful	- Document[1] - Internet[2]
Diagnosis	- Diagnosis by symptoms - Diagnosis by questions - Water analysis	- Experts[3] - Document - Internet
Non-infectious diseases	- Accessories of aquarium - Water quality and poisoning - Body of goldfish - Other	- Experts - Document - Internet
Treatment and Medication	- Methods - Dose - Drugs - Chemical use in diseases control	- Experts - Document - Internet

[1] Document : Textbooks and relevant journals

[2] Internet : Relevant websites

[3] Experts : Veterinarians, fish biologists and Aquarists

3.2. Computer Program Development

This step consisted of 3 separate procedures. The detail of each of the procedure could be described as follows:

3.2.1. Database Design

This procedures involved recording of related information into a database in the form that was simple to understand and to develop a computer program. Sets of two-dimensional tables were designed. Row represented a record of a file, while a column showed a record field (attribute). The preparation of the database for this study was conducted using Paradox 7 Database Management System. This was due to their simplicity to modify, update and add information.

3.2.2. Program Design

Program design involved a procedures of coding integrands into program units and compiling those units into modules. It could be divided into 3 steps as follows:

1) Programming language selection: Since Borland Delphi 6.0 possesses all general requirement for program design (30), it was accordingly chosen for this purpose.

2) Coding: In coding process, a flowchart was drawn prior to program coding. That described what would be done first, what next, what decisions was made, and what actions was repeated. In order to simplify the process further, symbols were also incorporated in the flowchart. For this study, IF_then_else and select_case form were used in coding program units.

3) Programming: For small program, which is hierarchical, a top-down approach for development would result in the most elegant, modifiable and reliable program (32). Therefore, top-down design was chosen as the method for developing the program in this study.

3.2.3. User Interface Design

This step involved designing user interface that served as an interactive path between a computer and a user. They were built from a set of common standard concepts. For this research, following three objects were used for improving friendliness of human-computer interaction.

1) Screens: Screen is an interactive technique that provides user convenience in using programs. In this research, two separate screens, which were input screens and output screens, were designed. The display of these screens was prepared using graphic user interface (GUI) technique that assisted users in understanding questions correctly and reduced difficulty of interaction between a computer program and a user.

2) Icon: Icons are graphical representation of particular objectives such as document, application and command. For this research, they were used to start and operate the developed computer program.

3) Natural Language: Natural language was the language that was used in a computer program for interaction between a computer and a user. It enabled a user to correctly provide information related to illness of his goldfish, hence raising chances to obtain properly matched results.

3.3. Program Testing

The objective of program testing was to determine the correctness and completeness of the developed computer program. The program was tested by five experts in the field of fish diseases (Table 3-2).

Table 3-2 Name and description of selected experts who evaluated the program.

Experts	Descriptions
Assoc.Prof.Dr.Nantarika Chansue	Head of Aquatic Animal Medicine Division, The Faculty of Veterinary Science, Chulalongkorn University.
Thitiporn Laowprasert	Aquatic Animal Health Research Institute, Department of Fisheries.
Umalai Sadoakdee	"
Assoc.Prof.Dr.Nontawit Areechon	Faculty of Fisheries, Kasetsart University.
Suntraporn Limsakul	"

In addition, forty students from Faculty of Fisheries, Kasetsart University, were chosen for answering questionnaires relevant to friendliness of the program. Half of them have already taken classes relating to fish diseases. The rest had no experiences in the subject.

After the program was tested, a questionnaire would be distributed and completed. It has a four point scale as 1 = improvement required, 2 = slight, 3 = moderate, 4 = good and 5 = excellent (43). Mode was calculated from the obtained data. And since this questionnaire included open-end questions, recommendation relating to the program could also be suggested.

3.4. Research Tools

3.4.1. Hardware

CPU	: At least Celeron 300 MHz.
RAM	: At least 64 MB.
Hard Disk	: Free areas on harddisk at least 90 MB.
Monitor	: Super VGA Monitor
Peripherals	: Keyboard, Mouse
Resolution (screen area)	: 1024 * 768 pixels

3.4.2. Software

Operating System	: Microsoft Windows 98
Compiler	: Borland Delphi 6.0
DBMS	: Paradox 7.0
Documentation	: Microsoft Word 97
Installer	: Borland Delphi 6.0 InstallShield

CHAPTER IV
RESULTS AND DISCUSSION

The computer program prototype for diagnosis of water quality related diseases of goldfish (*Carassius auratus*) in aquarium was developed and tested. The correctness and friendliness of the program were also tested by groups of fish diseases experts and student majoring in fisheries sciences.

4.1 Computer Program Development

Development processes were divided into 3 parts, which were 1) Database design, 2) Program implementation and 3) User interface design. Each part was conducted as follows:

4.1.1. Database Design

Information relevant to water quality related diseases and treatment were recorded in the specially designed tables. These consisted of 10 different tables that were 1) About Table, 2) Diseases Table, 3) Solution Table, 4) Goldfish Table, 5) Help Table, 6) Symptoms Table, 7) Varieties Table, 8) Prevention Table, 9) Data Source Table and 10) Agreement Table. The detail of each of the database table was described as follows:

1) About Table

'About Table' contained information relating to specified topics, which were objective of the program, program developer, acknowledgement and computer specification. The data structures of the table were shown in Table 4-1.

Table 4-1 Data structure of 'About Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Detail	Character	120	About of computer program

2) Diseases Table

'Diseases Table' consisted several information on water quality related diseases including diseases name, cause of illness, symptoms, and recommendation for suitable care. The data structures of the table were shown in Table 4-2.

Table 4-2 Data structure of 'Diseases Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Cause	Character	255	Cause of water quality related diseases
Symptom	Character	255	Symptom of water quality related diseases
Advi	Character	255	Advice for care goldfish
Name	Character	50	Water quality related diereses name

3) Solution Table

The information relating solution of the module 'Diagnosis by Symptoms' that was contained in 'Solution Table'. The data structures of 'Solution Table' were shown in Table 4-3.

Table 4-3 Data structure of 'Solution Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Detail	Character	240	Result of computer program

4) Goldfish Table

'Goldfish Table' contained information relating to goldfish, i.e. common names, good characteristics, care, as well as ecology and history. The data structure of the table was shown in Table 4-4.

Table 4-4 Data structure of 'Goldfish Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Detail	Character	120	Information relating to goldfish

5) Help Table

The information relating to user guide, troubles shooting, button explanatory and vocabulary was included in 'Help Table'. The data structure of the table was shown in Table 4-5.

Table 4-5 Data structure of 'Help Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Detail	Character	120	Help of computer program
Pic	Graphic	120	Pictures in help topic

6) Symptoms Table

Information and images of symptoms of water quality related diseases were stored in 'Symptoms Table'. They included breathing and swimming disorder, as well as external abnormality found in a sick fish. This information was displayed in screens of the module 'Diagnosis by Symptom'. The data structure of the table were shown in Table 4-6.

Table 4-6 Data structure of 'Symptoms Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Detail	Character	40	Topics of symptoms
Pic	Graphic	120	Pictures of symptoms

7) Varieties Table

'Varieties Table' contained information and images relating to different goldfish varieties. These included varieties name, as well as their characteristic and care. The data structure of the table was shown in Table 4-7.

Table 4-7 Data structure of 'Varieties Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Detail	Character	120	Information relating to goldfish varieties
Pic	Graphic	120	Images of goldfish varieties

8) Prevention Table

Information relating to prevention and treatment of water quality related diseases, especially in goldfish being kept in an aquarium, was stored in 'Prevention Table'. The data structure of the table was shown in Table 4-8.

Table 4-8 Data structure of 'Prevention Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Detail	Character	120	Prevention and treatment of water quality related diseases

9) Data Source Table

The information relating to sources of information, i.e. books, journals, website and institution was included in 'Data Source Table'. The data structure of the table was shown in Table 4-9.

Table 4-9 Data structure of 'Data Source Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Detail	Character	120	Source of information

10) Agreement Table

Agreement statements that required full acceptance from a user before operating the program, was contained in 'Agreement Table'. The data structure of the table was shown in Table 4-10.

Table 4-10. Data structure of 'Agreement Table'

Data	Data type	Field size	Description
ID	Integer	2	Identify code
Detail	Character	240	Agreement before use computer program

4.1.2. Program Implementation

This step included three separate elements of the program, i.e. flowchart preparation, program coding and user interface design. In order to ease the process of coding the program, hierarchy of the computer program could be described in a form of flowchart. For this study, two separate flowcharts of program coding for authorized and unauthorized were prepared. In the case of an authorized user, a password had to be input before using the program or editing stored information. A password was, however, not required from an unauthorized user who could only view information, diagnose diseases and calculate dose of medication needed for treatment. The flowcharts of authorized and unauthorized users were shown in Figure 4-1 and 4-2.

Program coding process was started after the program design including flowchart preparation was finished. For this study, a statement 'If_then_else and select_case' was used in coding the program. Examples of the program coding were shown in Appendix D.

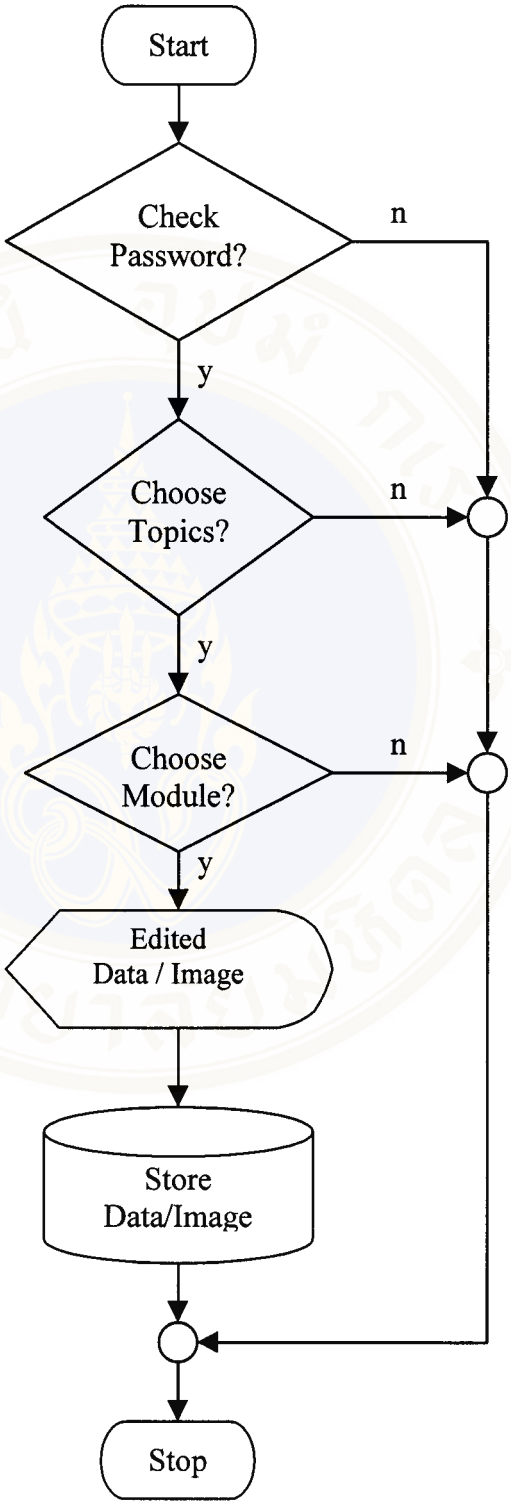


Figure 4-1 Flowchart of an authorized user.

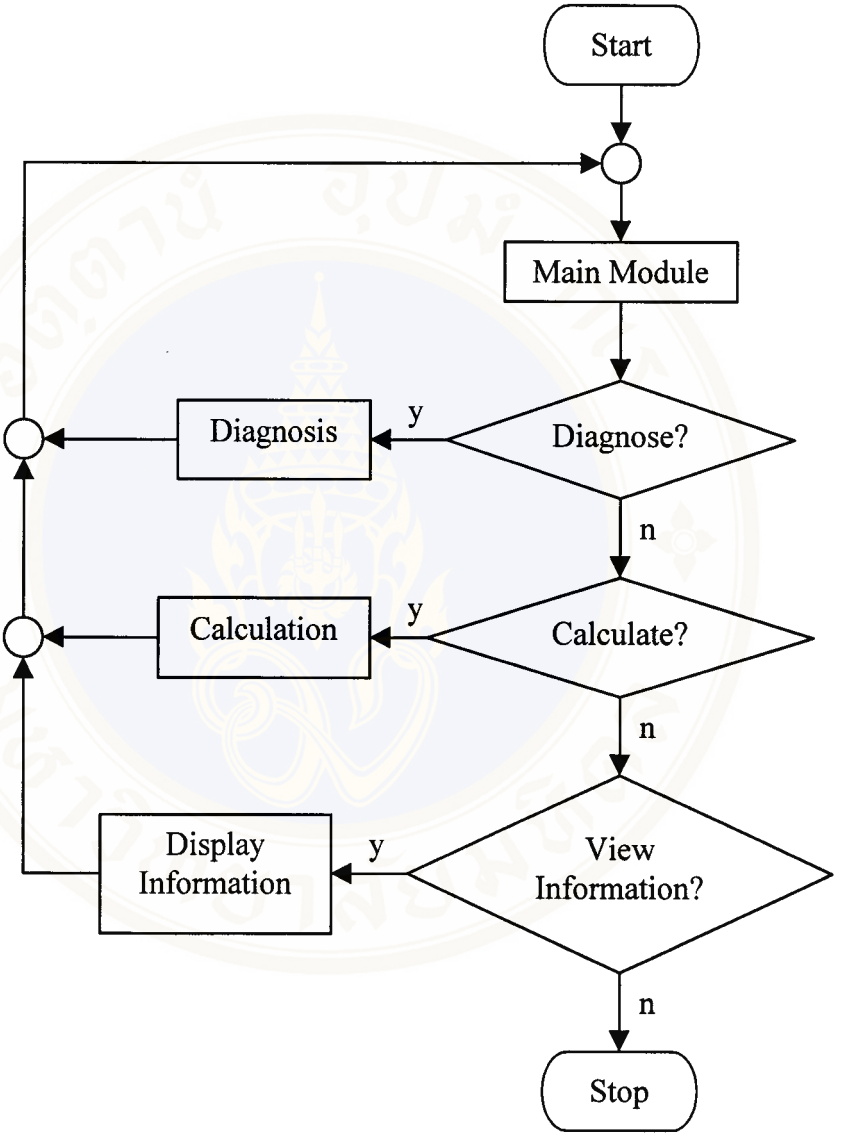


Figure 4-2 Flowchart of an unauthorized user.

The function hierarchy was encapsulated into main modules that consisted of 1) Goldfish, 2) Diagnosis by Symptoms, 3) Diagnosis by Questions, 4) Prevention and Treatment, 5) Calculation, 6) Source of Data and 7) About. Descriptions of these main modules were described as follows:

1. 'Goldfish' Module

Contents of this module contained information relating to goldfish, i.e. name, history, shape, varieties, good characteristic, ecology and useful. A user could gain knowledge concerning goldfish by viewing details in each of the topic. The information was displayed in two formats as text and images. The flowchart of the 'Goldfish' module was shown in Figure 4-3.

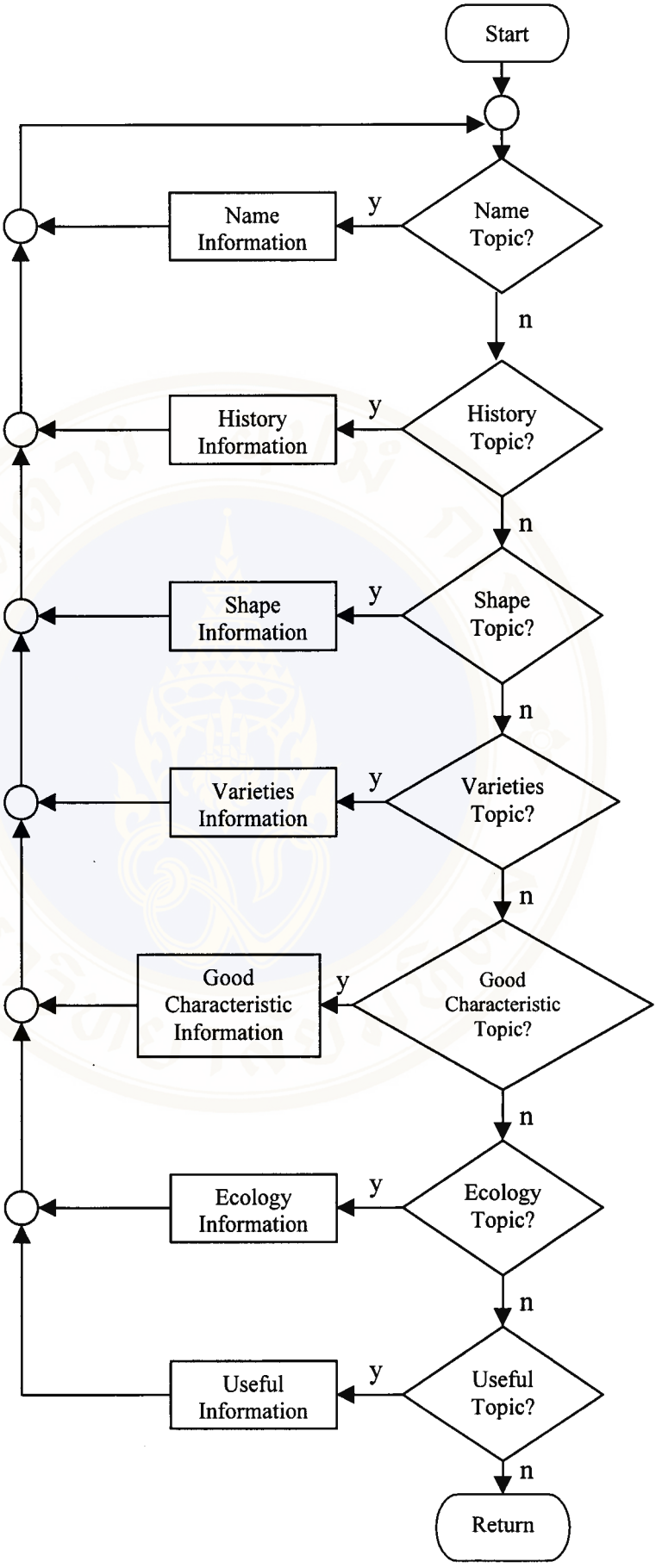


Figure 4-3 Flowchart of the 'Goldfish' module

2. 'Diagnosis by Symptoms' Module

This module enabled a user to identify water quality related diseases from observed symptoms. All of the diseases included in this program exist in Thailand. This module contained information on disorder behavior and symptom of these diseases for a user to choose from. This module was displayed in two formats as text (symptoms and recommendation) and images of symptoms and disorder behaviors associated with water quality related diseases. The flowchart of the 'Diagnosis by Symptoms' module was shown in Figure 4-4.

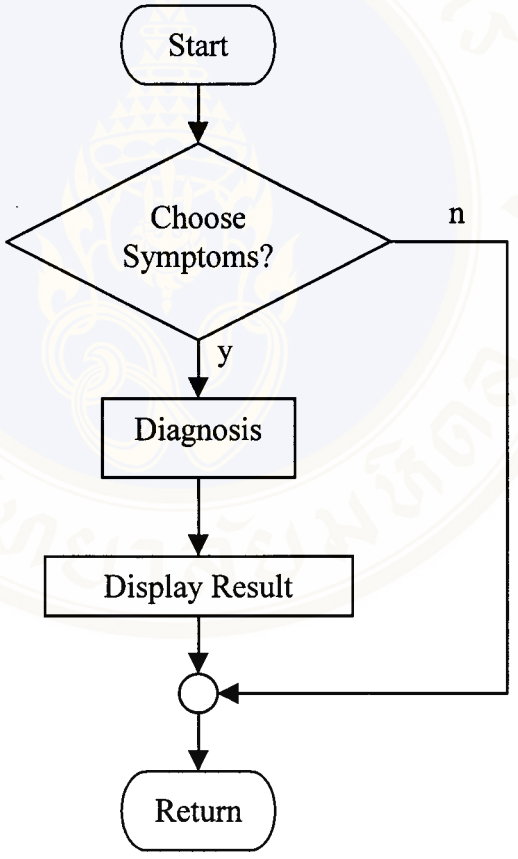


Figure 4-4 Flowchart of the 'Diagnosis by Symptom' module

3. 'Diagnosis by Questions' Mnodule

From this module, a user could recognize water quality related diseases from answering specific questions. These questions were related to problems that occurred to sick goldfish. This module consisted of 4 groups of questions, which concerned water quality, equipment and accessories, observed disorder behaviors, and other relating problems. Each of the topics contained several sequential questions for a user to response.

A solution of each diagnosis included both cause of illness and recommendation for proper treatments. In addition to display of a solution in a form of plain text, image of symptoms or disorder behaviors of specific diseases could also be viewed. The flowchart of the 'Diagnosis by Questions' module was shown in Figure 4-5.

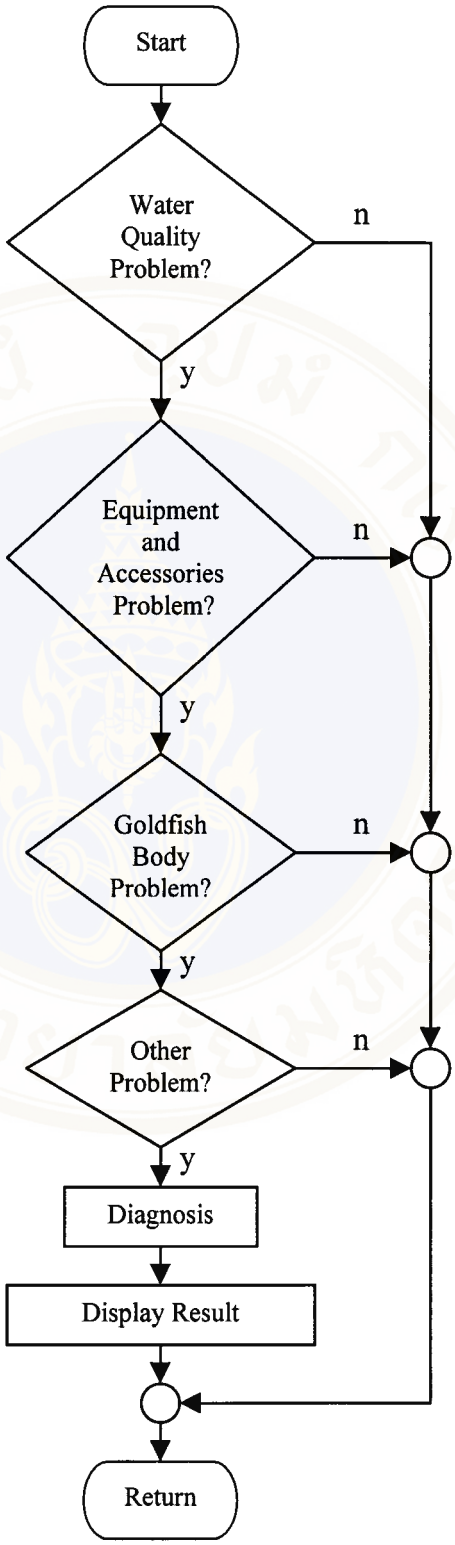


Figure 4-5 Flowchart of the 'Diagnosis by Questions' module

4. 'Prevention and Treatment' Module

This module contained information relating to prevention and treatment of water quality related goldfish diseases. It consisted of observation, cause of diseases, treatment, care and disease prevention. Information was displayed as text format. The flowchart of the 'Prevention and Treatment' module was shown in Figure 4-6.

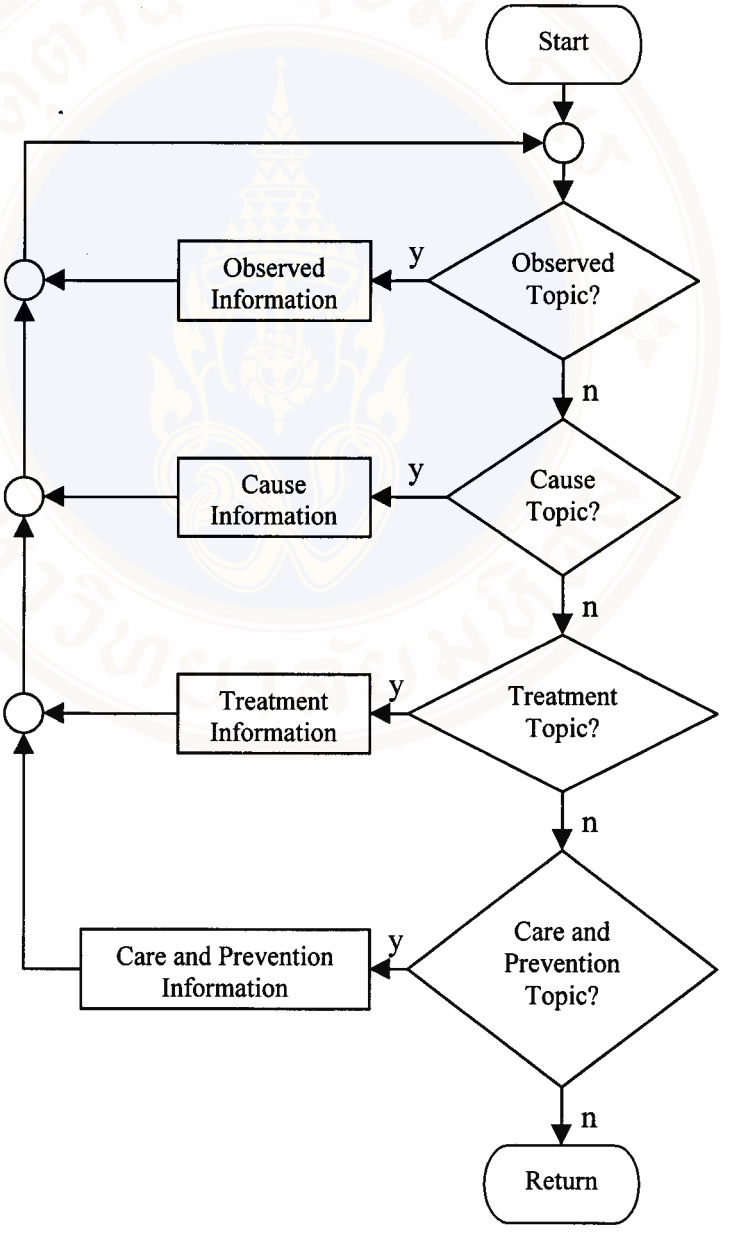


Figure 4-6 Flowchart of the 'Prevention and Treatment' module

5. 'Calculation' Module

This module enabled a user to calculate volume of water appropriate for a certain number of fish kept in an aquarium, as well as dose of medication required for treating sick fish. The flowchart of the 'Calculation' module was shown in Figure 4-7.

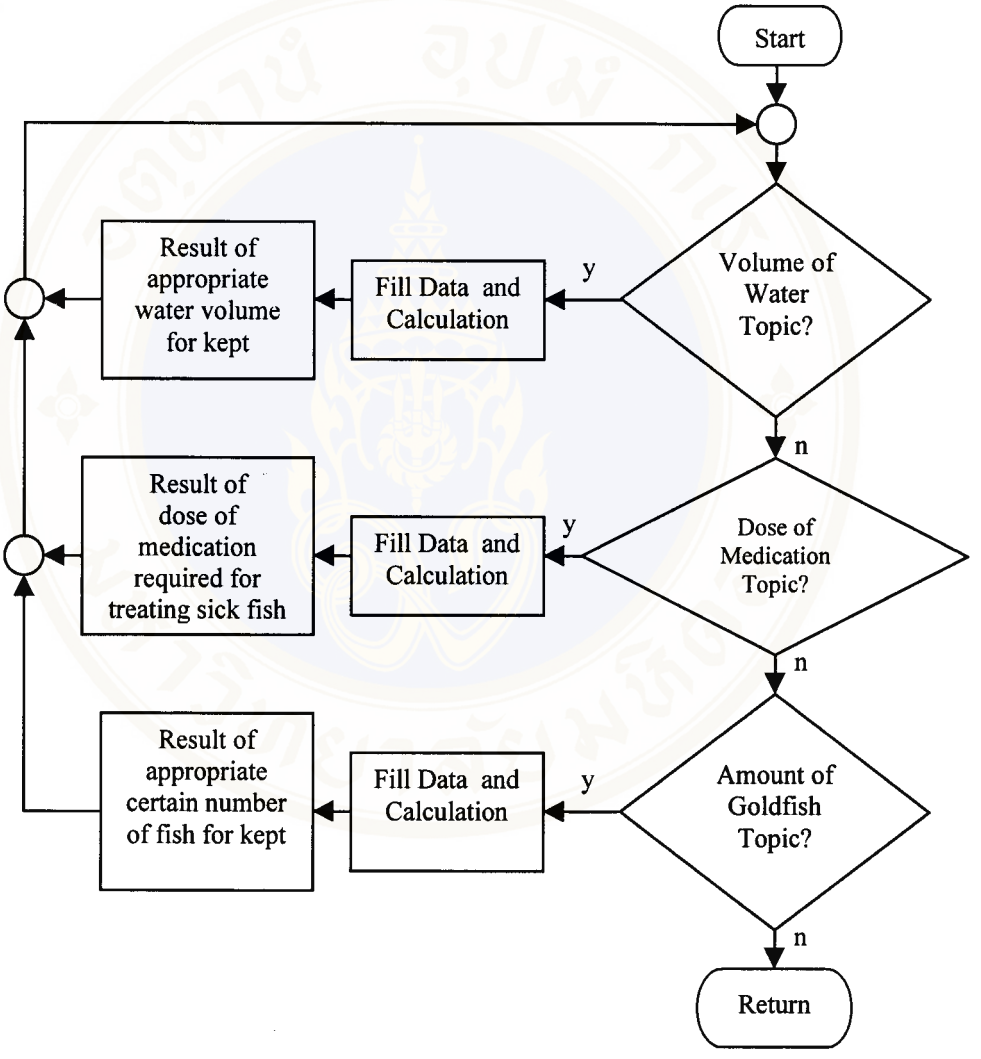


Figure 4-7 Flowchart of the 'Calculation' module

6. 'Source of Data' Module

This module contained cited information used in developing this computer program. This information was categorized into 3 topics that were Thai books, English books as well as Website and Institutes. It consisted lists of literature both in Thai and English, as well as website addresses and name of institutes. This module was displayed in text format. The flowchart of the 'Source of Data' module was shown in Figure 4-8.

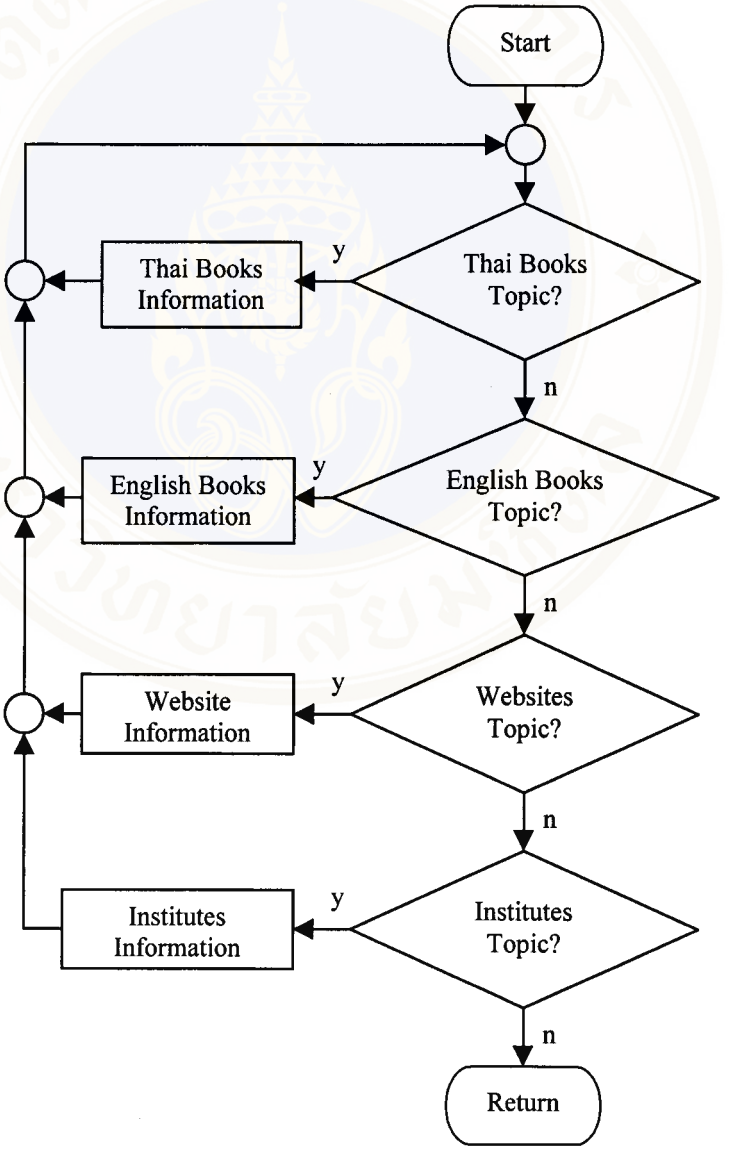


Figure 4-8 Flowchart of the 'Source of Data' module

7. 'About' Module

This module contained information relating to the developed computer program. It consisted of 4 topics, i.e. 1) objective 2) computer specification 3) developer and 4) acknowledgement. A user could check specification of required computer and information about the program developer. All Information was displayed as text format. The flowchart of the 'About' module was shown in Figure 4-9.

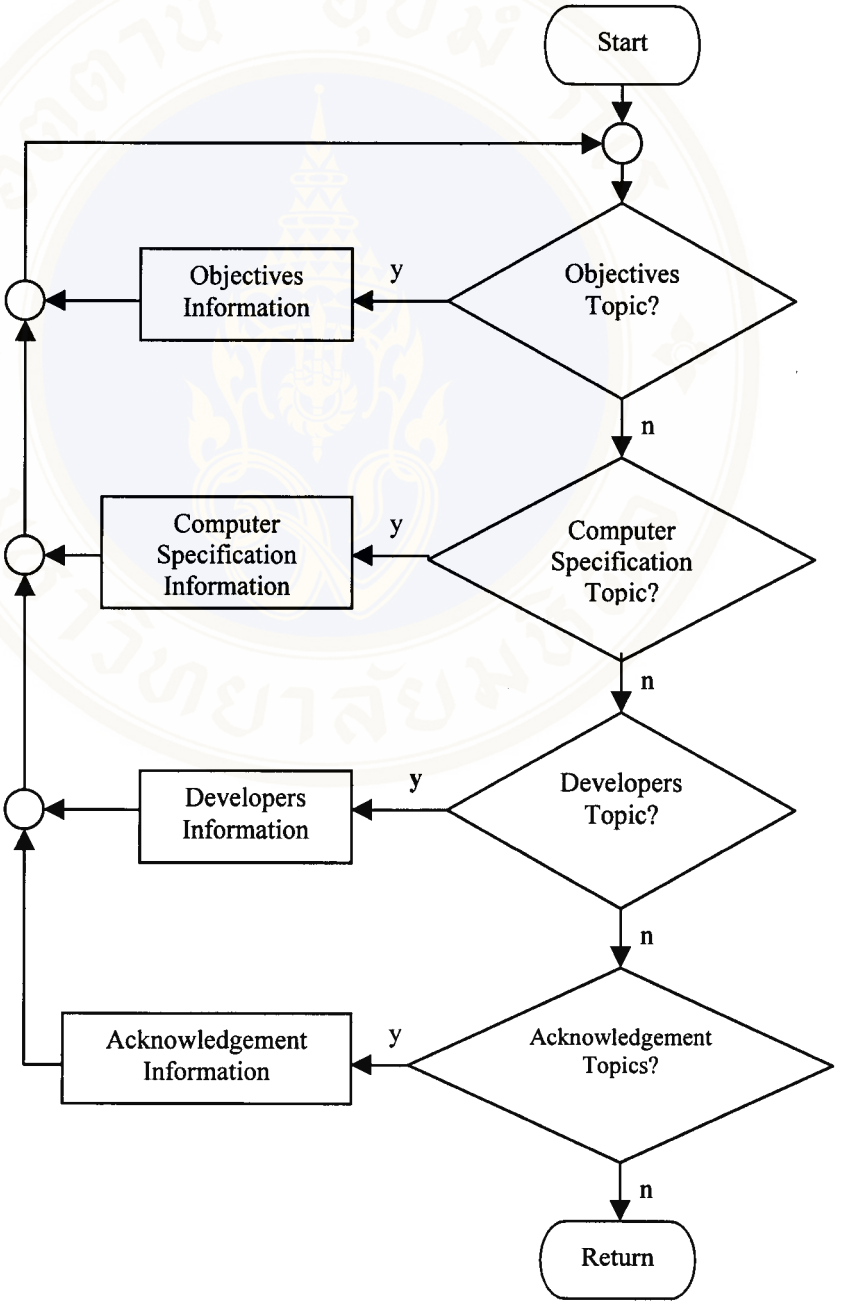


Figure 4-9 Flowchart of the 'About' module

4.1.3. User Interface Design

The user satisfaction is the quality of the user interface. There are many ways to judge the quality of the user interface that are ease of learning, speed of use, frequency of user errors, user satisfaction and knowledge retention (44). For this program, the user interface was divided into 2 categories, interaction styles and information displays.

1) Interaction Styles

Three interaction styles were designed as follows:

a. Menu Selection

In order to facilitate utilization of this diagnosis program, two different types of menus, i.e. single - screen menu as well as pull - down or pop - up menu were designed. In the single- screen menu design, all options were available from the current menu appearing on one single screen. An example of a single screen menu was shown in figure 4-10.

Figure 4-10 An example of a single screen menu.

The dose of drugs screen was one of the topic screen contained in the 'Calculation' module. Due to the requirement to select only one from the several drugs listed, this screen was designed in an interaction style of the pulls - down or pop - up menu. The user could activate the program by moving a cursor to the pulls - down or pop - up button and press. Then a small box would appear on the screen presenting the list of drugs. The user could choose it by moving the cursor over the desired drug and press. The menu box would disappear when the cursor moves off the menu box. The pull - down or pop - up menus screen was shown in Figure 4-11.

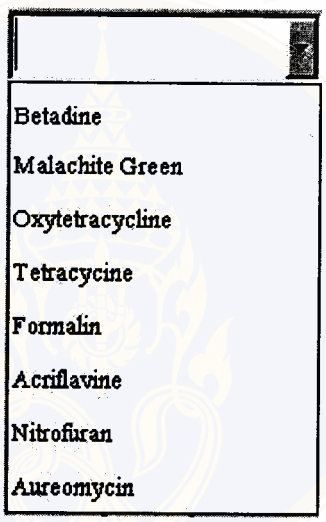


Figure 4-11 The pull - down or pop - up menus screen.

b. Form Fill - In

Form fill – in is an interaction style most suitable for the designed tasks where a significant amount of data entry was necessary (44). The user can fill data in the blank by moving mouse onto desired blank and typing the required data. Since form fill – in is similar to regular paper and pencil forms, the user would feel comfortable with the mode. Water Analysis screen belonging to the 'Calculation' module, was an example of screen designed in form fill – in interaction style.

A user could choose the screen of water analysis by moving the mouse onto the question "User have tool kit of water analysis?" and press. The screen contained 8 parameter blanks. In order to raise the possibility of receiving correct water analysis results, the user should fill in all blanks. In case some blanks were left unfilled, the computer program would automatically assume that acceptable level of

these parameters existed. Then, the user would have to press the analysis button for desired results. The screen of water analysis was shown in Figure 4-12.

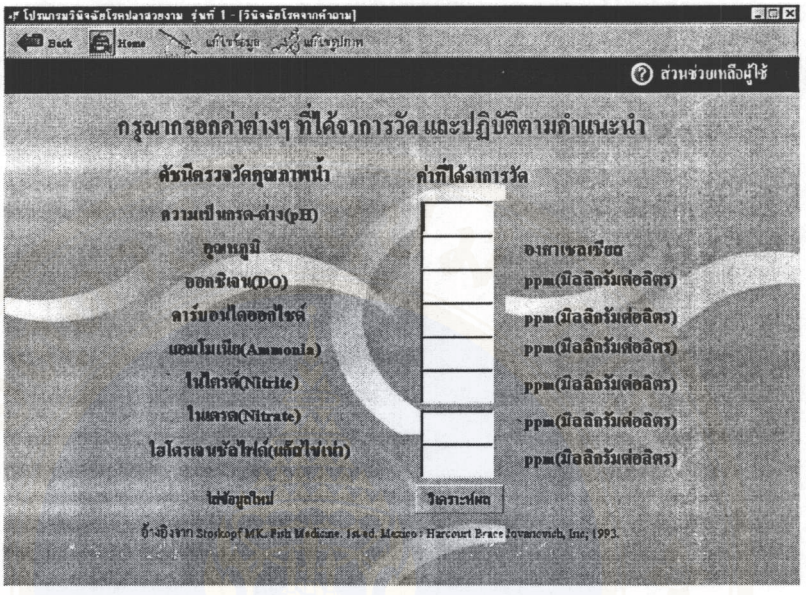


Figure 4-12 An example of form-fill in style designed as the interaction screen for water analysis

The 'Calculation' module has three topics for the user to choose. These topics consisted of volume of the water in aquarium, dose of drugs and amount of goldfish in your aquarium. The user can choose topics by moving the mouse onto the desired topic and press. In order to receive results, the user had to fill in all blanks. The tree topic screens of the 'Calculation' module were shown in Figure 4-13 to 4-15.

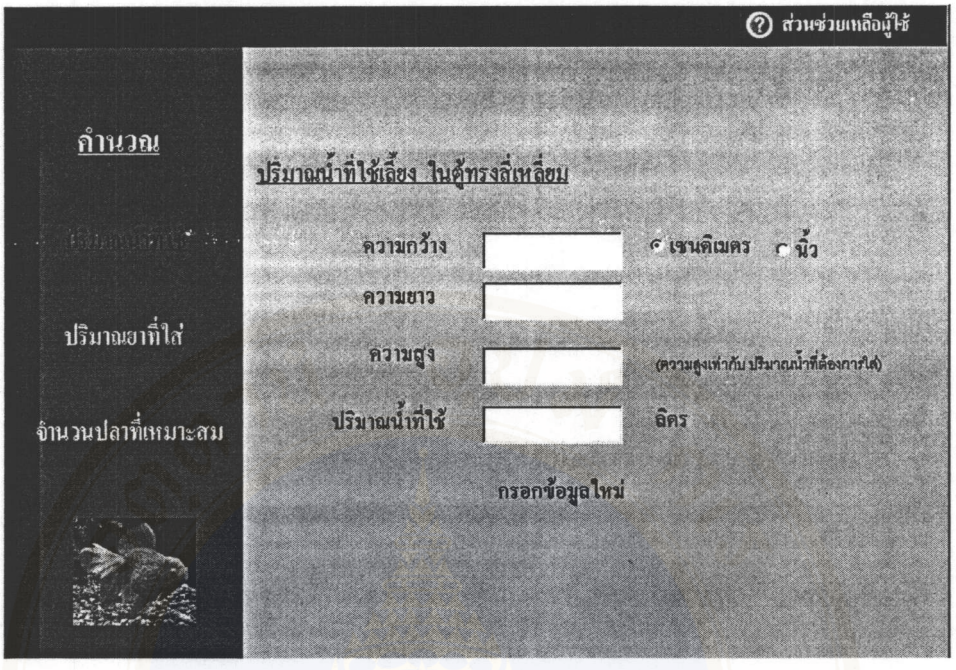


Figure 4-13 An example of form-fill in style designed as the interaction screen for calculating required volume of water.

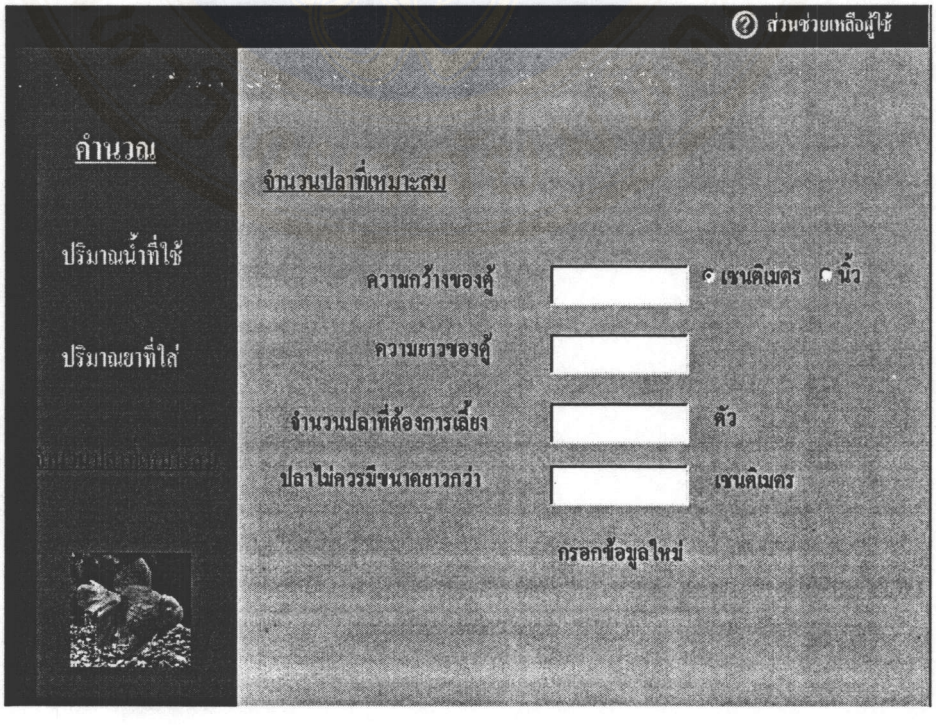


Figure 4-14 An example of form-fill in style designed as the interaction screen for calculating number of goldfish in an aquarium.

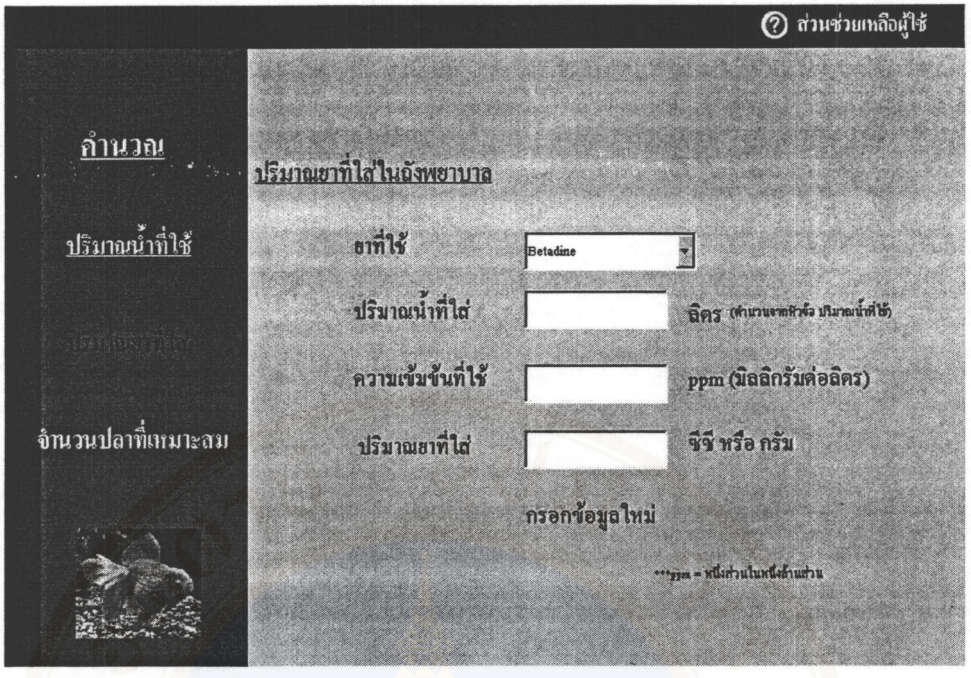


Figure 4-15 An example of form-fill in style designed as the interaction screen for calculating dose of drug.

c. Direct Manipulation

The components of a direct manipulation interface were the visual interface and a pointing device that could manipulate desired activities. For this program, buttons were used to represent commands, i.e. accept, reject, O.K., cancel, back, home, edit data and edit images. Examples of screens containing different command buttons were shown in Figure 4-16 to 4-20.

Figure 4-16 showed a screen containing agreement statement that all users had to be informed prior to entering the program. If the users agree with the statement, the accept button situated on the bottom left of the screen had to be pressed. The users, who reject the agreement, had to choose the cancel button to exit.

The login screen (Figure 4-17) was another example of a direct manipulation interface. The login screen was the security feature to prevent modification of stored information by regular users. Only authorized users, who have password, could edit data and images.

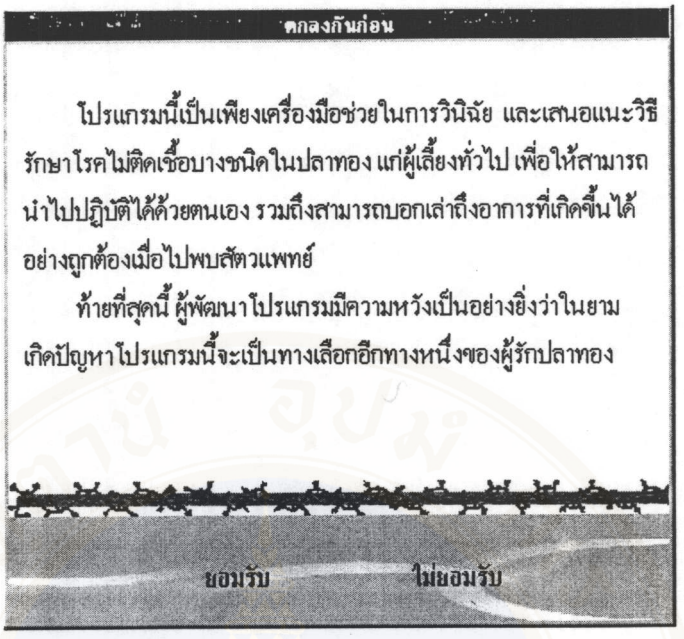


Figure 4-16 The agreement screen shows a statement required to be read by all users before entering the program. Two selective options in the form of command buttons situate at the bottom of the screen.

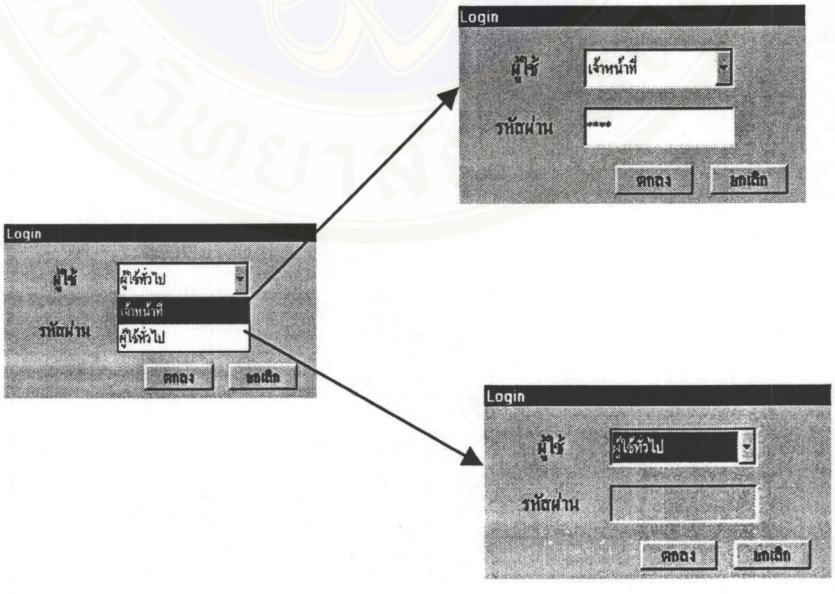


Figure 4-17 The login screens showing options for two different user groups.

Figure 4-18 and 4-19 showed a toolbar containing command buttons, i.e. back, home data editing and image editing. Both authorized and regular users could use the back button and the home button. Previous screens would be shown if users chose the back button. However, when the home button was pressed, the main screen would be shown instead. The data and image editing buttons were accessible only by the authorized user. They could edit stored data if the data editing button was pressed. Images could also been modified, if they chose the image editing button.

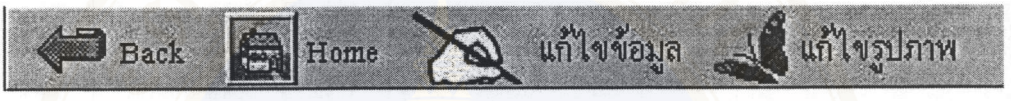


Figure 4-18 The toolbar containing command buttons for data and image editing specified for authorize users.

Figure 4-19 The toolbar containing command buttons for data and image editing inaccessible for regular users.

This program also possessed a user help button. This button was an option for users to choose when problems eventually occurred. After press on this button, the user help screen would be shown.

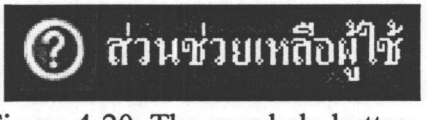


Figure 4-20 The user help button.

2) Information Display

The stored information could be displayed both as text and images. They were divided in four categories as follows:

a) General Information

Screens that showed general information relating to goldfish were linked to the four modules 'Goldfish', ' Prevention and Treatment', 'Source of Data', and 'About' (Table 4-11). Four display screens used for each module were shown in Figure 4-21 to 4-24.

Table 4-11 Topics and display formats of each module.

Modules	Topics	Display format
Goldfish	Name, History, Shape, Varieties, Good characteristics, Ecology and Usefulness	Text and Images
Prevention and treatment	Symptom observation, Cause of diseases, Treatment, Care and Prevention	Text
Source of data	Thai books, English books, Website and Institutes	Text
About	Objectives, Computer specification, Developer and Acknowledgement	Text

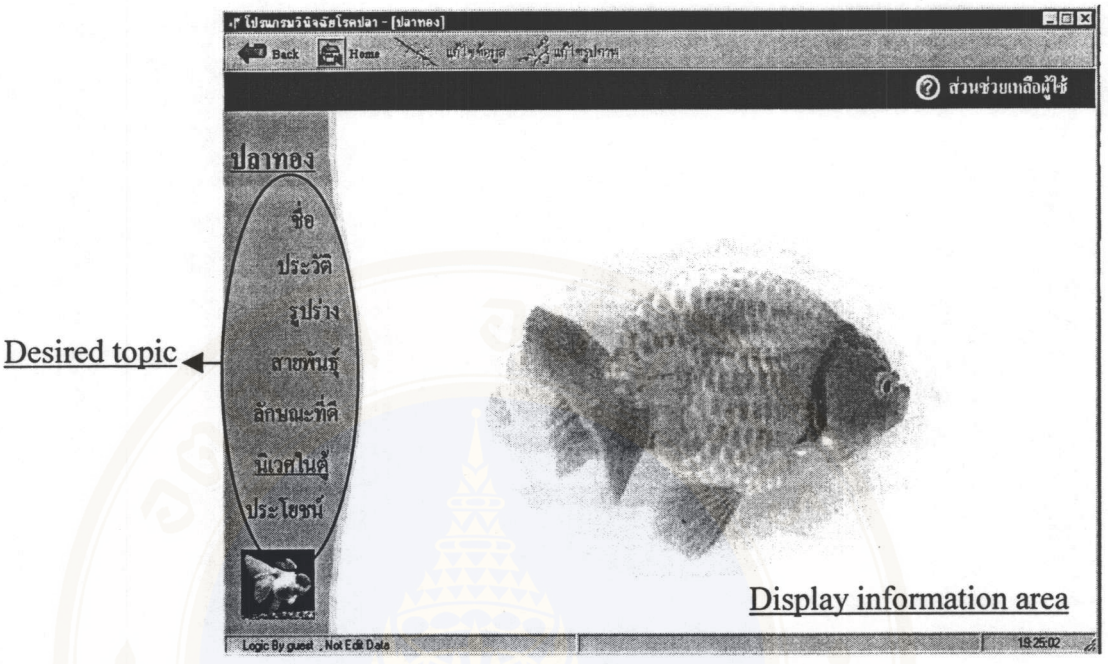


Figure 4-21 The display screen of the 'Goldfish' module.

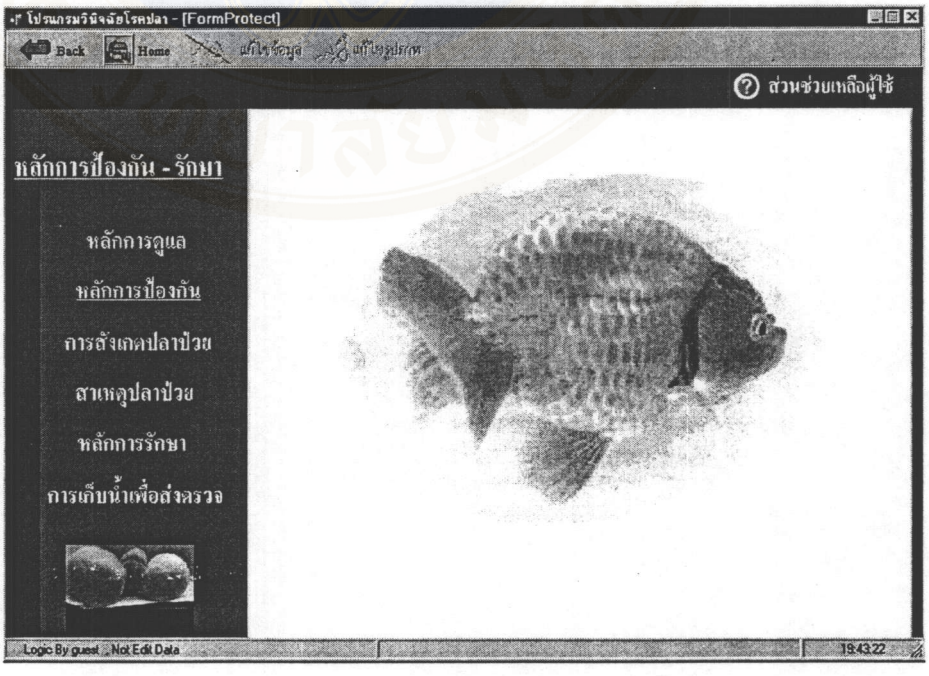


Figure 4-22 The display screen of the 'Prevention and Treatment' module.

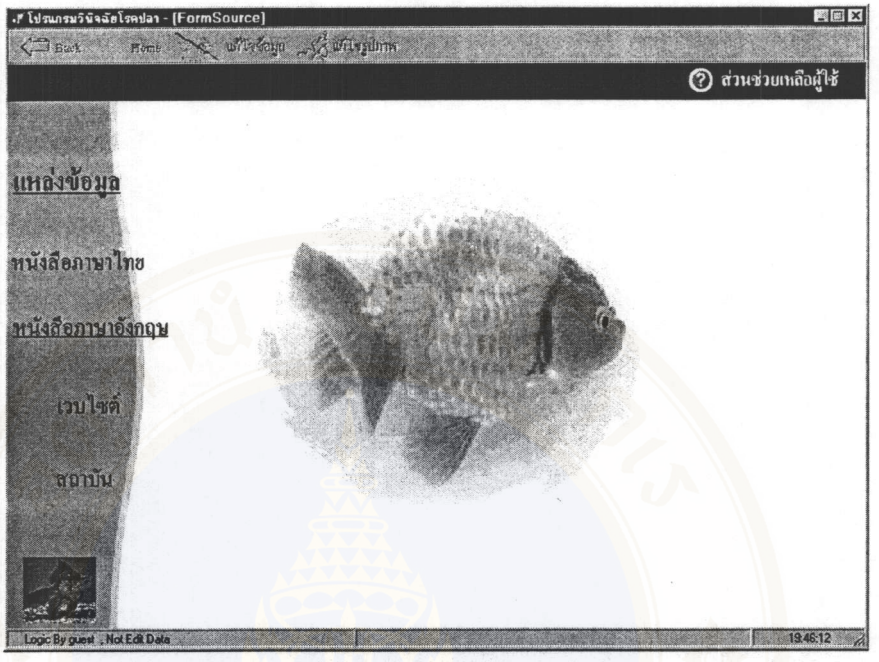


Figure 4-23 The display screen of the 'Source of Data' module.

Figure 4-24 The display screen of the 'About' module.

b) Diagnosis

Separate display screens were designed for the two diagnosis modules. For the 'Diagnosis by Symptoms' module, two display formats including images and movies could be viewed. (Figure 4-25). When a symptom in blue fonts was selected, an image showing the defined symptom could be seen. Movies, however, could only be seen associated with red fonts. For the 'Diagnosis by Questions' module, four problem topics, including water quality or poisoning, equipment or accessories, body and other concerned problems were separately grouped (Figure 4-26). In most of the cases, images would also be displayed when a specified question was chosen. The user would have to choose questions until the result of the diagnosis by questions was displayed.

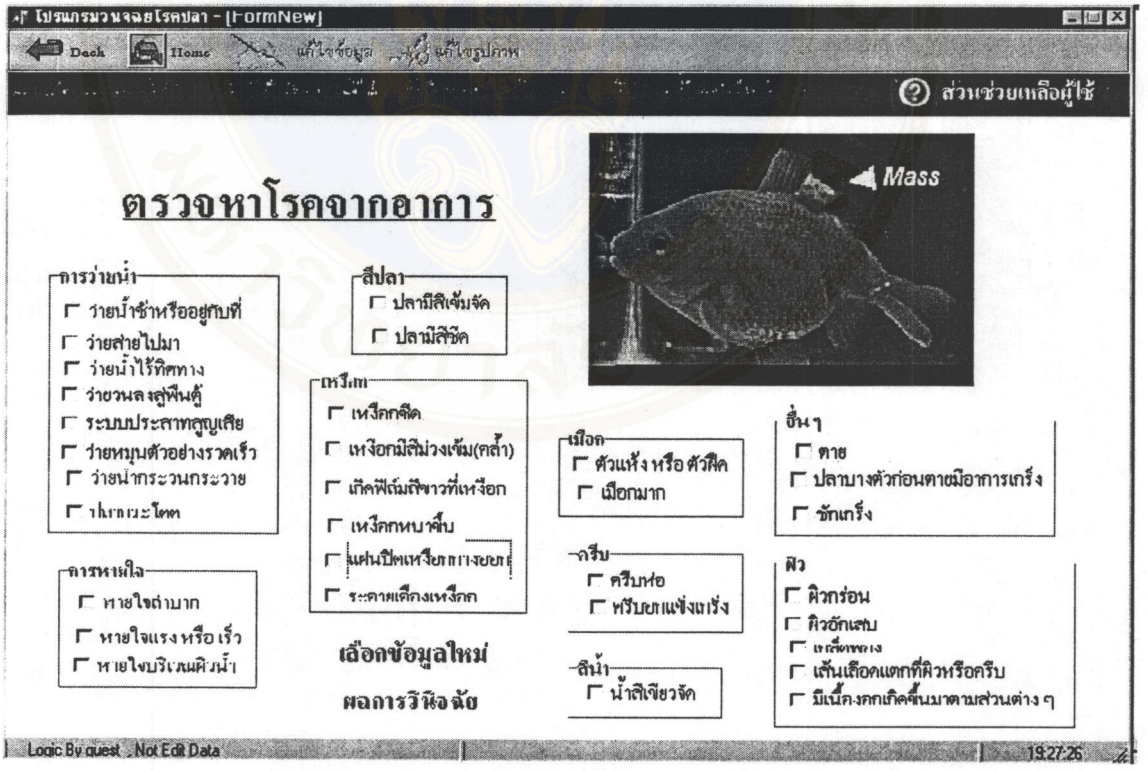


Figure 4-25 The display screen of the 'Diagnosis by Symptoms' module.

Figure 4-26 The display screen of the 'Diagnosis by Questions' module.

c) Results

Three separate screens were designed for displaying results of the diagnosis including 'Diagnosis by Symptoms' and 'Diagnosis by Questions'. Results of 'Diagnosis by Symptoms' module would be displayed in the screen shown in Figure 4-27. It consisted of number of possible diseases, causes, symptoms and treatment. From this screen, 'Diagnosis by Questions' could also be directly linked by selecting the specified button. For 'Diagnosis by Questions', results would be displayed in the screen shown in Figure 4-28. The information would consist of diseases, causes and recommendation relevant to the treatment. From this screen, the user can also go directly back to the screen of 'Diagnosis by Symptoms'.

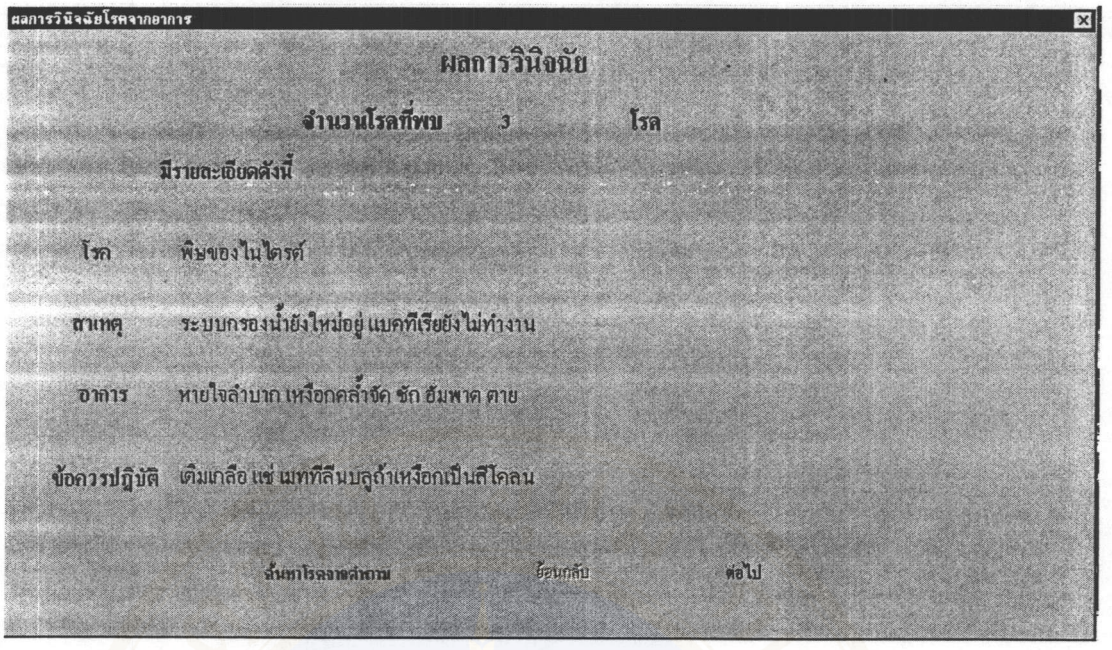


Figure 4-27 The display screen of the results obtaining from 'Diagnosis by Symptoms'

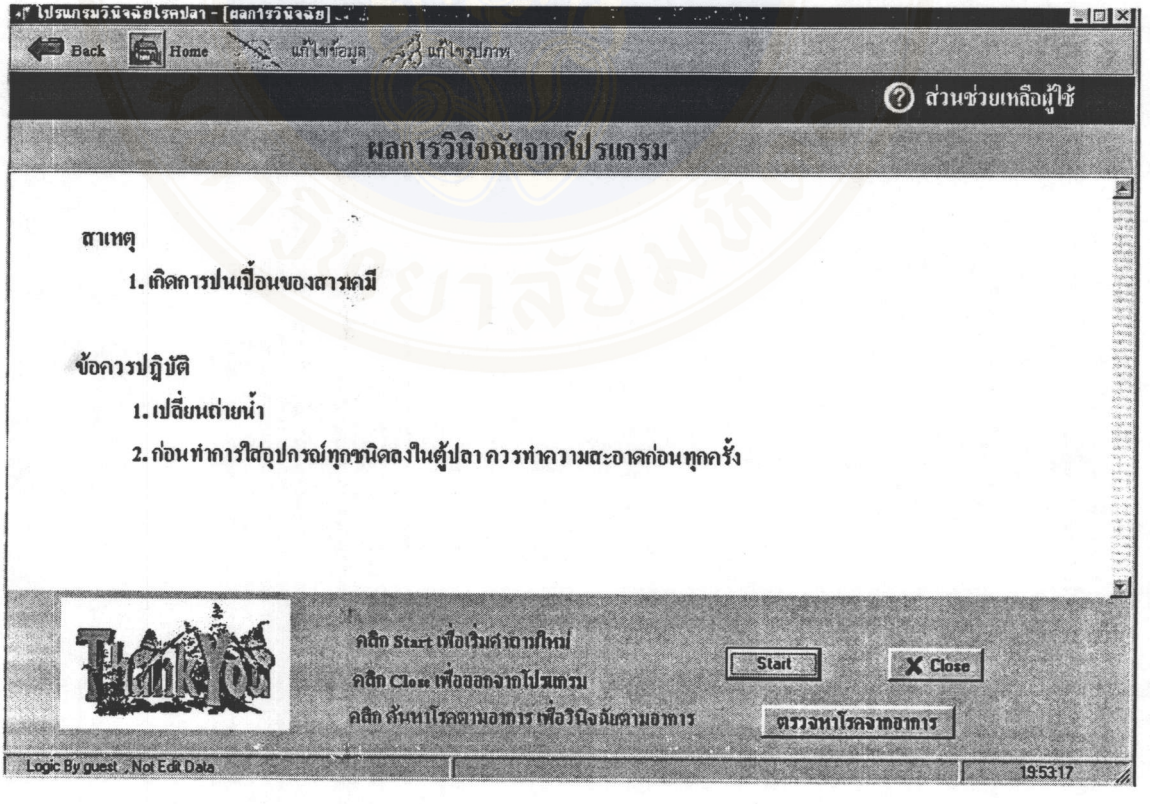


Figure 4-28 The display screen of the results obtaining from 'Diagnosis by questions'

d) User Help

A user help screen consisted of four topics, which are vocabulary, button explanation, using guideline and troubleshooting. From each topic, a user can choose any desired keywords shown on the left side of the screen. The result of the desired keywords would then be displayed on the screen where an image of two goldfishes is shown (Figure 4-29).

Figure 4-29 The display screen of the user help.

4.2. Program Testing

Testing activities are normally divided into verification and validation (45). Verification checks whether results agree with the specification of the program developer. However, this alone does not guarantee satisfaction of a user. Validation checks whether results really are, what the program developer actually wants. This focus mainly on user satisfaction.

This study used 2 different questionnaires as a tool for conducting the test. They were filled up by five fish disease experts and 40 student as described in 3.3. Three topics were included in each questionnaire which were program correctness, user friendliness and recommendation.

The opinion of the experts on level of correctness of the program was mostly good (Table 4-12). This indicated satisfaction and acceptance of the experts on results of diagnosis. According to 'moderate' response on the topics of content and 'Diagnosis by Symptoms', minor modification should be done.

Table 4-12 Evaluation results of the program correctness obtained from five experts in fish diseases field.

Topics	Results
1. Illustrations	Good
2. Wordings used in modules 'Diagnosis by Questions' and 'Diagnosis by Symptoms'	Good
3. Content of the program	Moderate
4. Results of the module 'Diagnosis by Questions'	Good
5. Result of the module 'Diagnosis by Symptoms'	Moderate
6. Result of the submodule 'Water Analysis'	Good
7. Consistency of results obtained from the program and from an expert	Good
8. Satisfaction of an expert on obtained results	Good
9. Possibility of using the program to diagnose and treat water quality related diseases of goldfish in aquarium	Good

Friendliness of the program was evaluated both by five fish diseases experts and forty students. The other twenty students have not experiences on the subject. The evaluation results from both student groups (Table 4-13) indicated great similarity in opinion.

Table 4-13 Evaluation results of program friendliness obtained from five fish disease experts, as well as from 40 students, half of them had experiences in the field.

User evaluation	Experts	Students	
		Experienced	Non-experienced
1. Attractiveness of illustrates	Good	Good	Good
2. Practicability of running the program by using Illustrations	Good	Good	Good
3. Interesting of contents	Excellent	Good	Good
4. Clarity of contents	Good	Good	Good
5. Suitability of font sizes	Excellent	Excellent	Excellent
6. Lay out of user interface screen components	Excellent	Excellent	Excellent
7. Friendliness of user interface	Excellent	Excellent	Excellent
8. Advantage of 'User Help' module	Good	Good	Good
9. Ease in installing the program	Good	Good	Good
10. Satisfaction in speed of the program	Good	Good	Good
11. Overall opinion on the program	Excellent	Good	Good

The expert gave few recommendations on improvement of the program. More information, including nutritional and neoplastic diseases should be added to the 'Content'. The sequence of information should be rearranged, so that the readability of the content would be improved. Moreover, images and movies on symptoms of illness, as well as details for each result of diagnosis should be added to the 'Diagnosis by Symptoms' module.

Both of the student groups shared similar opinion on the friendliness of the program. They found that the user interface of this program computer were user friendly. It was also simple to use. Illustrates were interesting and helpful in identifying symptoms. The content of the program was suitable for self learning. The Times New Roman font for English and AngsanaUPC font for Thai were also appropriate for reading.

Few disadvantages of the program involving difficulty in installing the program, as well as its slow speed in viewing the program were reported. These probably resulted from employing Borland Delphi 6.0 for user interface design. The image and movie component of Delphi supports only file type of bitmap and AVI, which require large memory to execute and to store. This extends waiting periods when images and movies are retrieved.

This program can assist hobbyist of goldfish who lack of experience in the subject of fish diseases, especially in diagnosis and treatment of water quality related diseases of goldfish in aquarium. It contains images and movies of symptoms that help a user to understand symptoms correctly. The program is quite different from other available diagnosis programs. Usually, only illness symptoms are used in other disease diagnosis programs (37,38). However, three different diagnosis modules that are 'Diagnosis by Questions', 'Diagnosis by Symptoms' and 'Water Analysis' can be used in this program. Additionally, the 'Display information modules' containing basic information on goldfish is provided. Therefore, by operating this program, a user can diagnose, interpret water quality data and review relating information about goldfish.

CHAPTER V
CONCLUSION AND RECOMMENDATION

5.1. Conclusion

A computer program prototype for diagnosis of water quality related diseases of goldfish (*Carassius auratus*) in aquarium was developed. Due to its suitability for small software development, a top-down model was used for developing the program. Information relevant to the program was collected from both primary and secondary sources. They were obtained from interviewing experts in the field, as well as reviewing scientific literatures, journals and internet. These data was recorded into database tables designed by Paradox 7.0. Database in this studying has ten design tables that consist of 1) About Table, 2) Diseases Table, 3) Solution Table, 4) Goldfish Table, 5) Help Table, 6) Symptoms Table, 7) Varieties Table, 8) Prevention Table, 9) Data Source Table and 10) Agreement Table.

For coding condition sentences 'If_then_else and select_case', Borland Delphi 6.0 was employed. For the program, 91 cases were coded, 21 for the result of 'Diagnosis by Symptoms' module, 59 for the result of 'Diagnosis by Questions' module and 11 for the result of water analysis. Prior to the actual process of program development, program flowcharts were prepared. Their purpose were to show function hierarchy of the program which in turn would improve understanding of the task and ease program implementation. For preparation of user interface, the Graphic User Interface (GUI) was applied. Accordingly, for this study three different interaction styles, which were menu selection, form fill-in and direct manipulation, were chosen relative to information required to display. Four information display screens included ' Detail, Diagnosis, Result and User Help' were designed.

The program consisted of seven main modules, which were 'Goldfish', 'Prevention and Treatment', 'Source of Data', 'About', 'Diagnosis by Symptoms', 'Diagnosis by Questions' and 'Calculation'. The first four modules were for displaying information, while the last three modules for diagnosis and calculation. The main modules contained 3 display formats that were text, images and movies. Overall, 56 images and 6 movies were included, 13 images and 6 movies for

'Diagnosis by Symptoms' modules and 43 images for 'Diagnosis by Questions' modules.

Two different questionnaires were tool for testing correctness and efficiency of the program. They were completed by five fish disease experts and 40 student from the Faculty of Fisheries, Kasetsart University. Questionnaire for the students contains subjects relating to user friendliness and recommendation, while the one for the experts also included questions on program correctness. The opinion of the experts on level of correctness of the program was mostly good. This indicated their satisfaction and acceptance on results of diagnosis. Friendliness of the program was evaluated both by the experts and students. They were quite please with the program and generally voted it as good. However, a few suggestions on the content of the program was given by the experts. More information, including nutritional and neoplastic diseases should be added. The sequence of information should also be rearranged, in order to improve readability of the content. Moreover, images and movies on illness symptoms, as well as details for each diagnosis result should be added to the 'Diagnosis by Symptoms' module.

5.2. Recommendation

1. Since resolution of screen area in most personal computers is set at 800 * 600 pixels, the program should accordingly be adjusted.
2. Information in the program should be updated regularly.
3. More images and movies of symptoms and disorder behaviors of water quality related goldfish diseases should be added in the computer program.
4. For further development of the computer program, other non-infectious diseases should also be incorporated.
5. For further development of a more flexible computer program for diagnosis of fish diseases, entity-relationship model should be used for database design.

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APPENDIX A
QUESTIONNAIRES

Questionnaire for experts to evaluate

The computer program prototype for diagnosis of water quality related diseases of goldfish (*Carassius auratus*) in aquarium.

This program is thesis of Mr.Teerasak Mataderm

Faculty of Graduate Studies

Mahidol University

Check √ into desired box

Part I : Evaluation of correctness	Improve	Slight	Moderate	Good	Excellence
1. Illustrations					
2. Wordings used in modules 'Diagnosis by Questions' and 'Diagnosis by Symptoms'					
3. Content of the program					
4. Results of the module 'Diagnosis by Questions'					
5. Result of the module 'Diagnosis by Symptoms'					
6. Result of the submodule 'Water Analysis'					
7. Consistency of results obtained from the program and from an expert					
8. Satisfaction of an expert on obtained results					
9. Possibility of using the program to diagnose and treat water quality related diseases of goldfish in aquarium					

Part II : Evaluation of user interface	Improve	Slight	Moderate	Good	Excellence
1. Attractiveness of illustrates					
2. Practicability of running the program by using Illustrations					
3. Interesting of contents					
4. Clarity of contents					
5. Suitability of font sizes					
6. Lay out of user interface screen components					
7. Friendliness of user interface					
8. Advantage of 'User Help' module					
9. Ease in installing the program					
10. Satisfaction in speed of the program					
11. Overall opinion on the program					

Part III : Recommendation

_____

_____

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_____

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_____

Name_____ Last name_____

Position_____

office_____

Questionnaire for regular users to evaluate of
computer program for diagnosis and treatment water quality related diseases
of goldfish(*Carassius auratus*) in aquarium.
This program is thesis of Mr.Teerasak Mataderm
Faculty of Graduate Studies
Mahidol University

Check √ into desired box

Part I : Evaluation of user interface	Improve	Slight	Moderate	Good	Excellence
1. Attractiveness of illustrates					
2. Practicability of running the program by using Illustrations					
3. Interesting of contents					
4. Clarity of contents					
5. Suitability of font sizes					
6. Lay out of user interface screen components					
7. Friendliness of user interface					
8. Advantage of 'User Help' module					
9. Ease in installing the program					
10. Satisfaction in speed of the program					
11. Overall opinion on the program					

Part II : Recommendation

_____

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_____

Name_____ Last name_____

Position_____

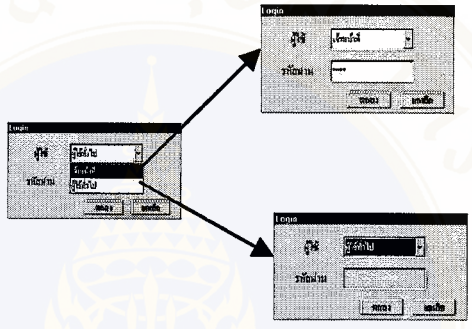
office_____

APPENDIX B

USER GUIDE

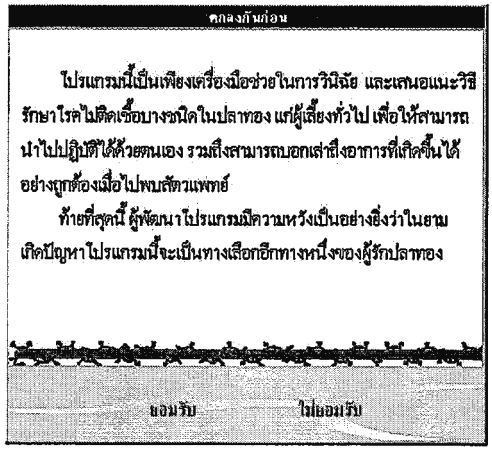
1. Double click on icon 

2. If the user is the unauthorized user, they will choose the word "Guest" in the box of user type and press OK button. The unauthorized user can view information and diagnosis only.

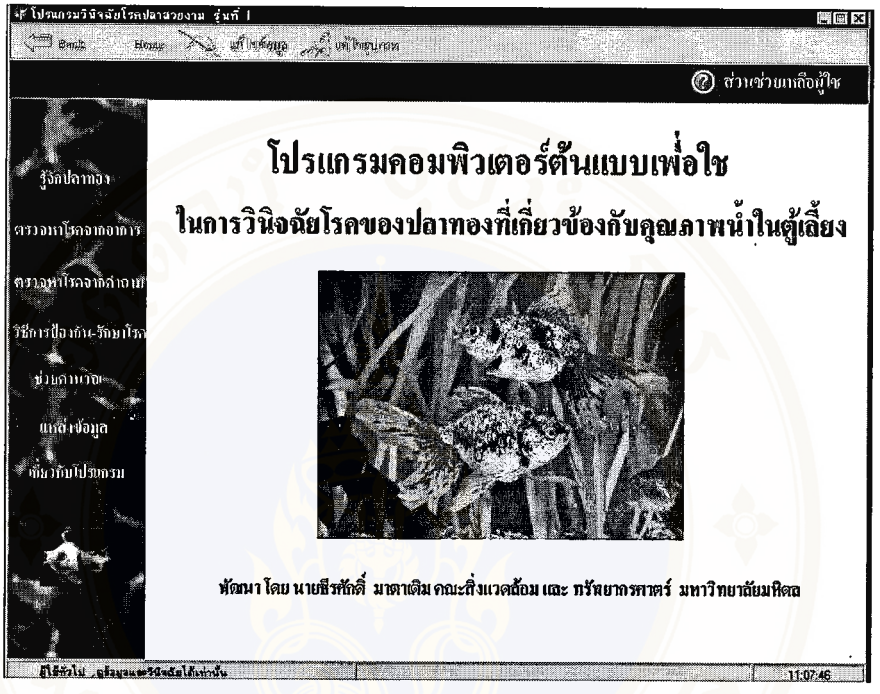


But if the user is the authorized user, the user will choose the word "administrator" in the box of user type. Then they have to entry password and press OK button. The authorized user can view information, diagnosis and edit information. But if both users would like to exit computer program, they will have to press cancel button.

3. Press accept button to start computer program or press reject button to exit computer program.



4. On main screen, it has 7 main modules: 'Goldfish', 'Diagnosis by Symptoms', 'Diagnosis by Questions', 'Prevention and Treatment', 'Calculation', 'Source of Data' and 'About'. The user can choose module by moving the mouse onto the desired module and press.

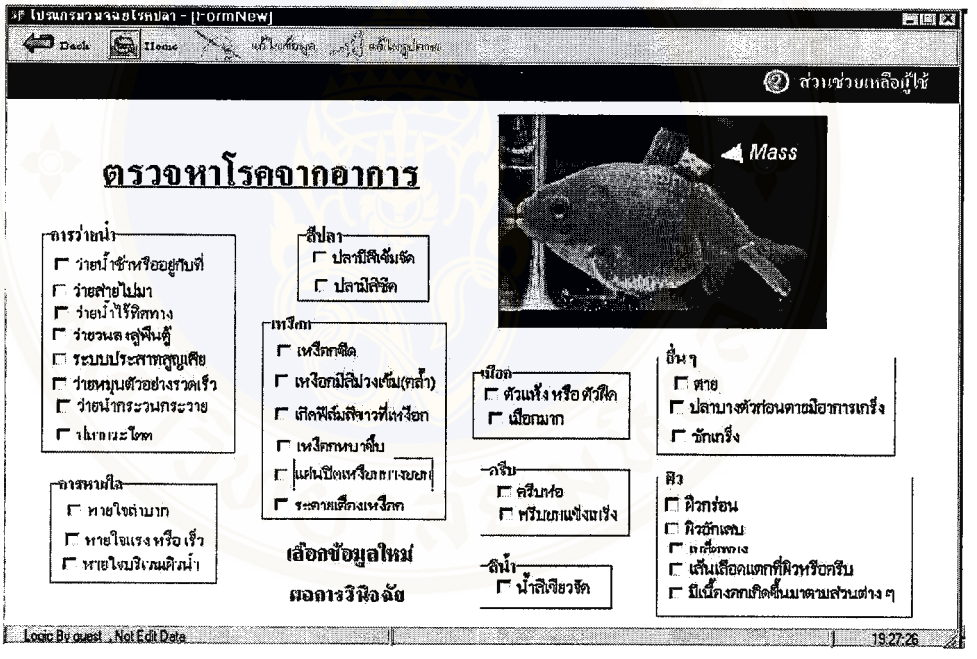


4.1. 'Goldfish' module

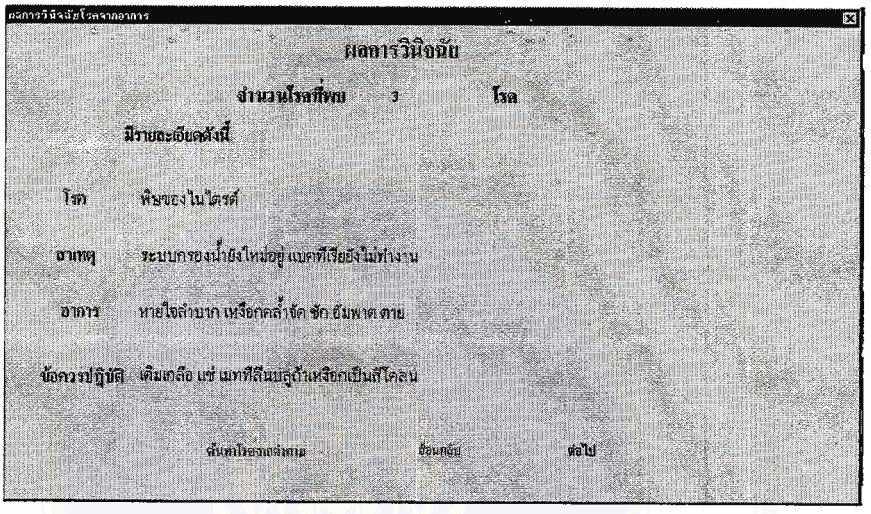
The user have to choose 'Goldfish' module and press, if the user would like to view information relating to goldfish. In this screen, it has 7 topics for the user to choose such as Name, History, Shape, Varieties, Good Characters, Ecology and Useful. The user can choose topic by moving the mouse onto the desired topic and press. Then the information of the desired topic will be displayed.

4.2. 'Diagnosis by Symptoms' module

The user has to choose 'Diagnosis by Symptoms' module, if the user would like to diagnosis the water quality related diseases of goldfish in aquarium by symptoms. This screen has groups of symptoms for the user to choose. This module has illustrates of symptoms. The user can view illustrate by moving mouse onto the desired symptoms that is blue font and press, the image of desired symptom will be displayed. As well as the user can view movies of desired symptom by moving the mouse onto the desired symptom that is red font and press, the movie of desired symptom will be shown.



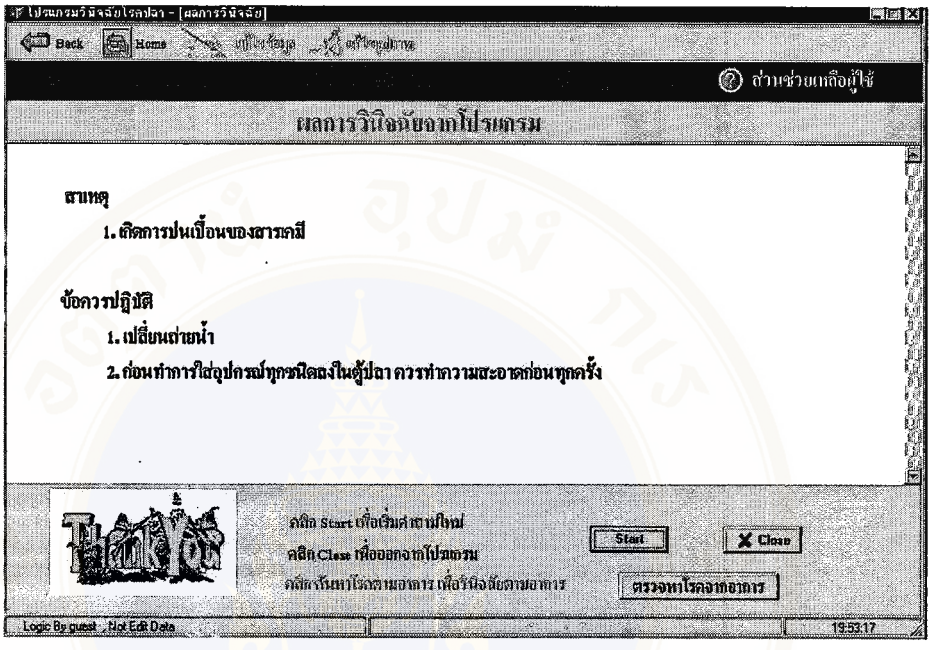
The user can choose the symptom that goldfish appeared by moving the mouse onto the check box and pressing. The screen of result will be displayed. This screen user can go to diagnosis by question by moving the mouse onto the button of diagnosis by questions and pressing.



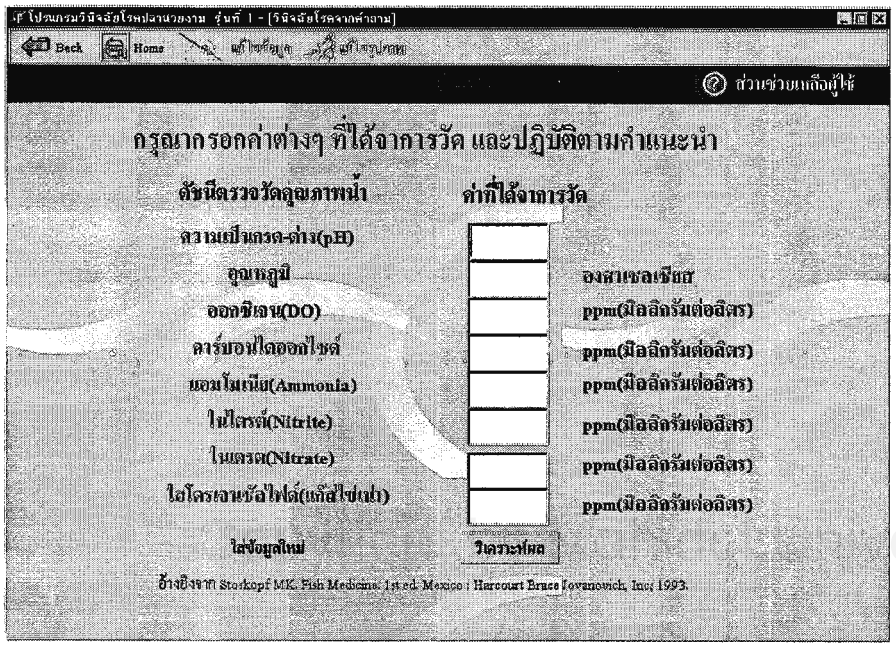
4.3. 'Diagnosis by Questions' module

The user have to choose 'Diagnosis by Questions' module, if the user would like to diagnosis the water quality related diseases of goldfish in aquarium. The first screen of diagnosis by questions, the user have to choose topics of problem that goldfish appeared. Each of topics will have questions for user to choose. Some questions have illustrates that will be displayed when the user move mouse onto the question. As well as, illustrate will disappear when the user move the mouse off the question.

The user can choose the question by moving the mouse onto the question and pressing. The user has to choose the question until the result of diagnosis by question display.



This submodule has water analysis. The user can go to the screen of water analysis by moving the mouse onto the question "User have toolkit of water analysis?" and pressing. The screen of water analysis has 8 blanks of parameters for the user fill data. Then the user has to moving the mouse onto analysis button and pressing, the result screen of water analysis will be displayed.

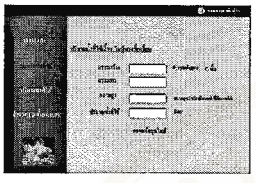
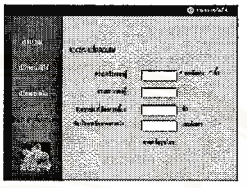
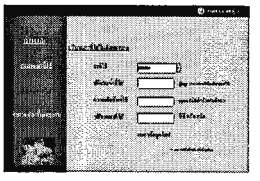


4.4. 'Prevention and Treatment' module

If the user would like to view information relating to prevention and treatment of the water quality related diseases of goldfish in aquarium, the user have to choose 'Prevention and Treatment' module and pressing. In this screen has 5 topics for the user to choose such as Observing, Cause, Treatment, Caring and Prevention. The user can choose the topic by moving the mouse onto the desired topic and pressing. Then the information of the desired topic will be displayed.

4.5. 'Calculation' module

If user would like to calculate volume of water in aquarium, dose of drugs and amount of goldfish in your aquarium, the user will choose topics of 'Calculation' module through moving mouse onto desired topic and pressing.

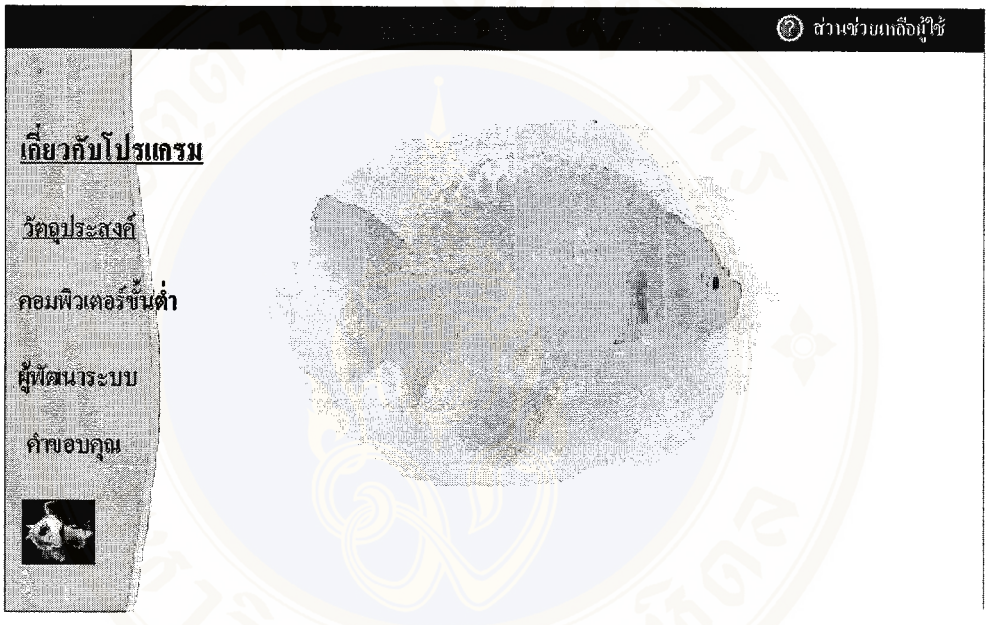
Each of topics has blanks for the user to fill data. The user have to fill data in all blanks and press the calculated button then the program will be processed and showed the result.

4.6. 'Source of Data' module

The user has to choose the 'Source of Data' module, if the user would like to view information relating to the source of data of this program. In this screen has 4 topics for the user to choose such as Thai Books, English Books, Website and Institutes. The user can choose the topic by moving the mouse onto the desired topic and pressing. Then the information of the desired topic will be displayed.

4.7. 'About' module

The user has to choose 'About' module, if the user would like to view information. In this screen has 4 topics of information for user to choose as Objective, Computer Specification, Program Developer and Acknowledgement. The user can choose the topic by moving the mouse onto the desired topic and pressing. Then the information of topic will be displayed.

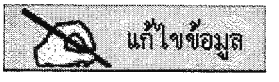


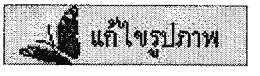
5. The user can view user help information by moving mouse onto the 'User Help' button and pressing. Then the 'User Help' screen will be displayed.

The 'User Help' screen will have 4 topics that consisted of Vocabulary, Button Explanatory, User Guide and Troubleshooting. The user can choose the topic by moving the mouse onto the desired topic and pressing. Then the screen of desired topic will be displayed.

6. Both user can go to the previous screen by press on 

7. Both user can go to the main screen by press on 

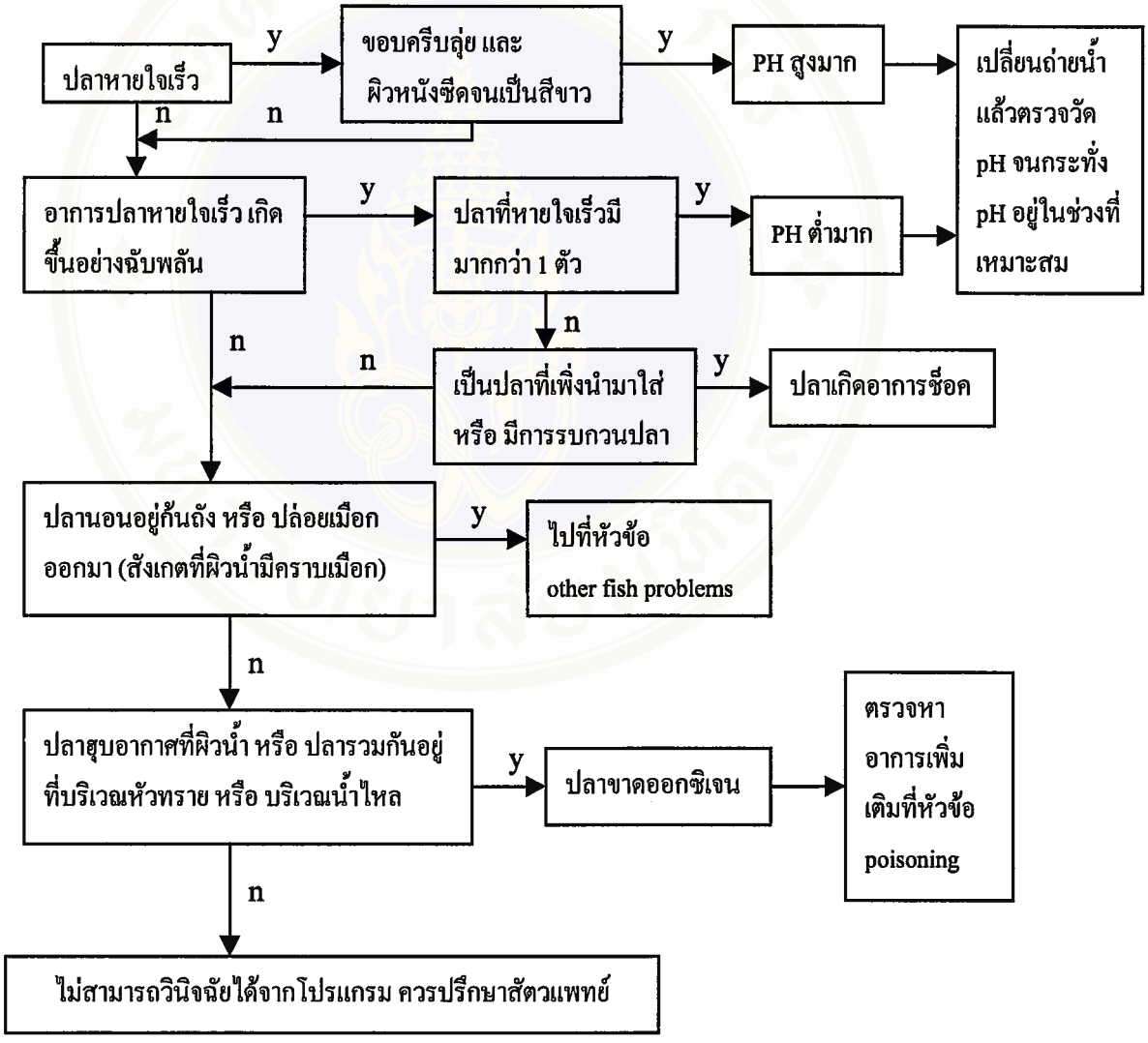
8. The authorized user can edit data by moving the mouse onto 

and pressing the OK button. If the user would like to reject edited data, user will press on the cancel button.
9. The authorized user can edit image by moving the mouse onto 

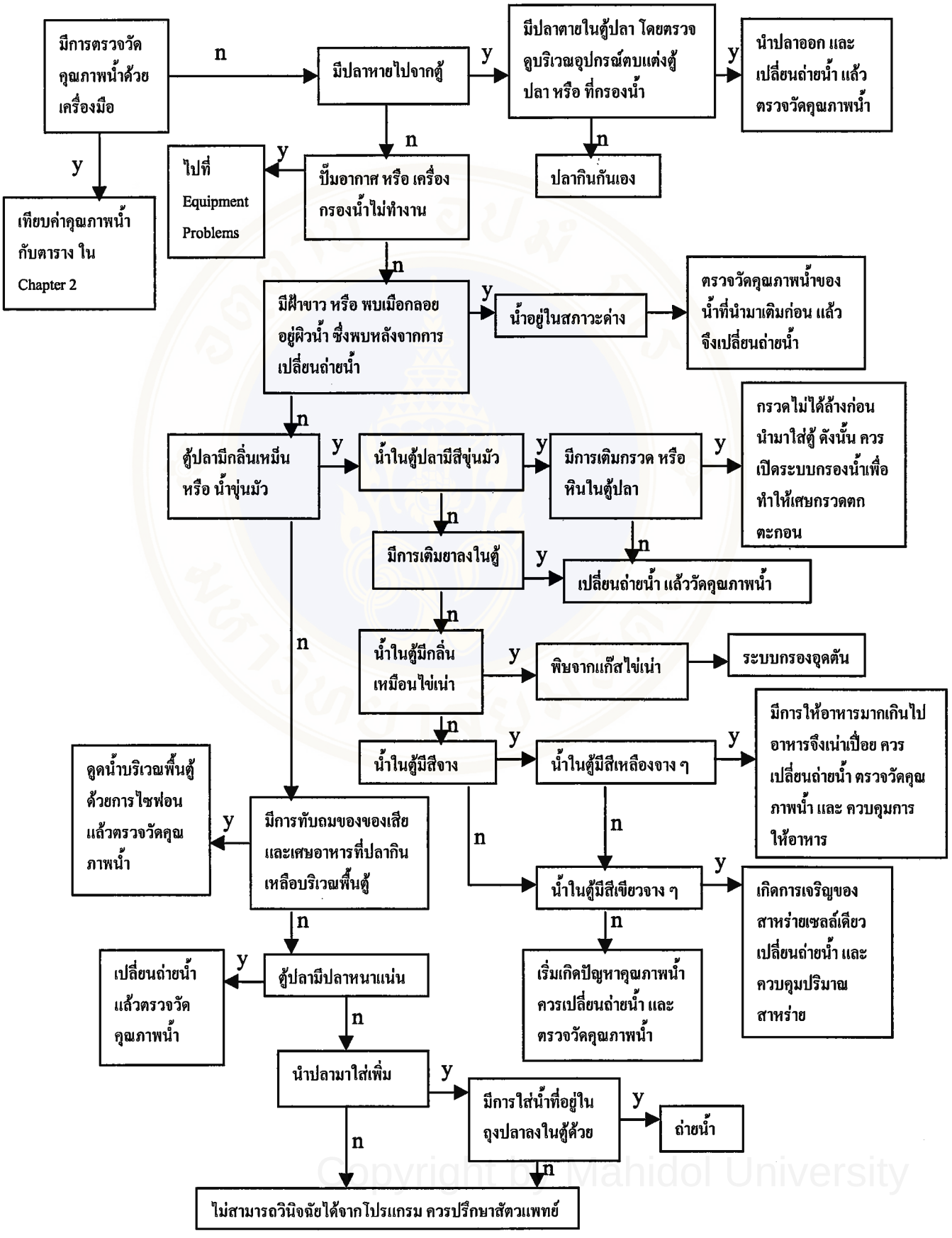
and pressing. Then edited image screen will be shown, the user can edit data and press the OK button. If user would like to reject edited image, user will press on the cancel button.
10. The user can exit the computer program by press on 

APPENDIX C
EXAMPLE OF DIALOGE CHART OF DIAGNOSIS BY QUESTIONS

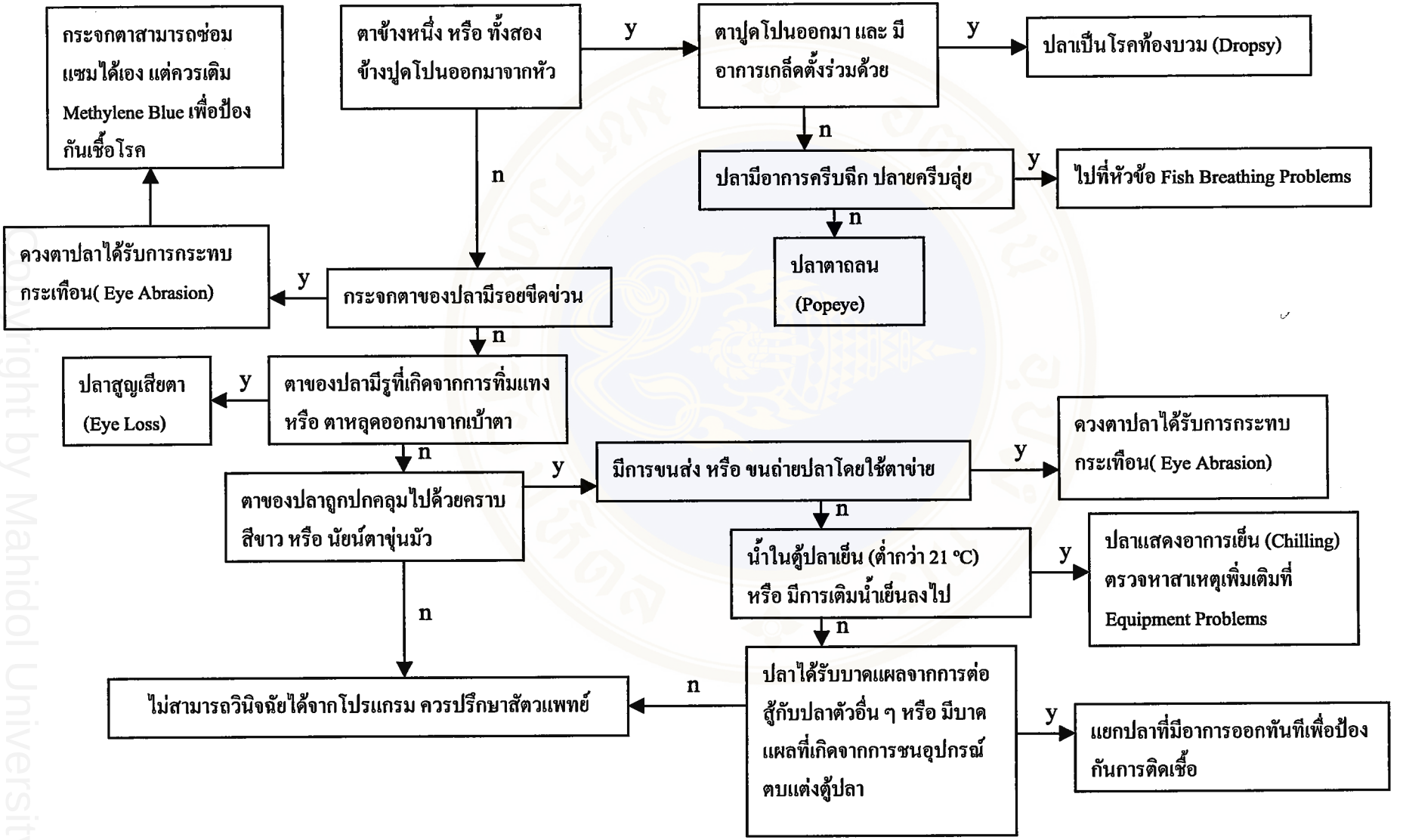
TOPIC : FISH BREATHING PROBLEMS

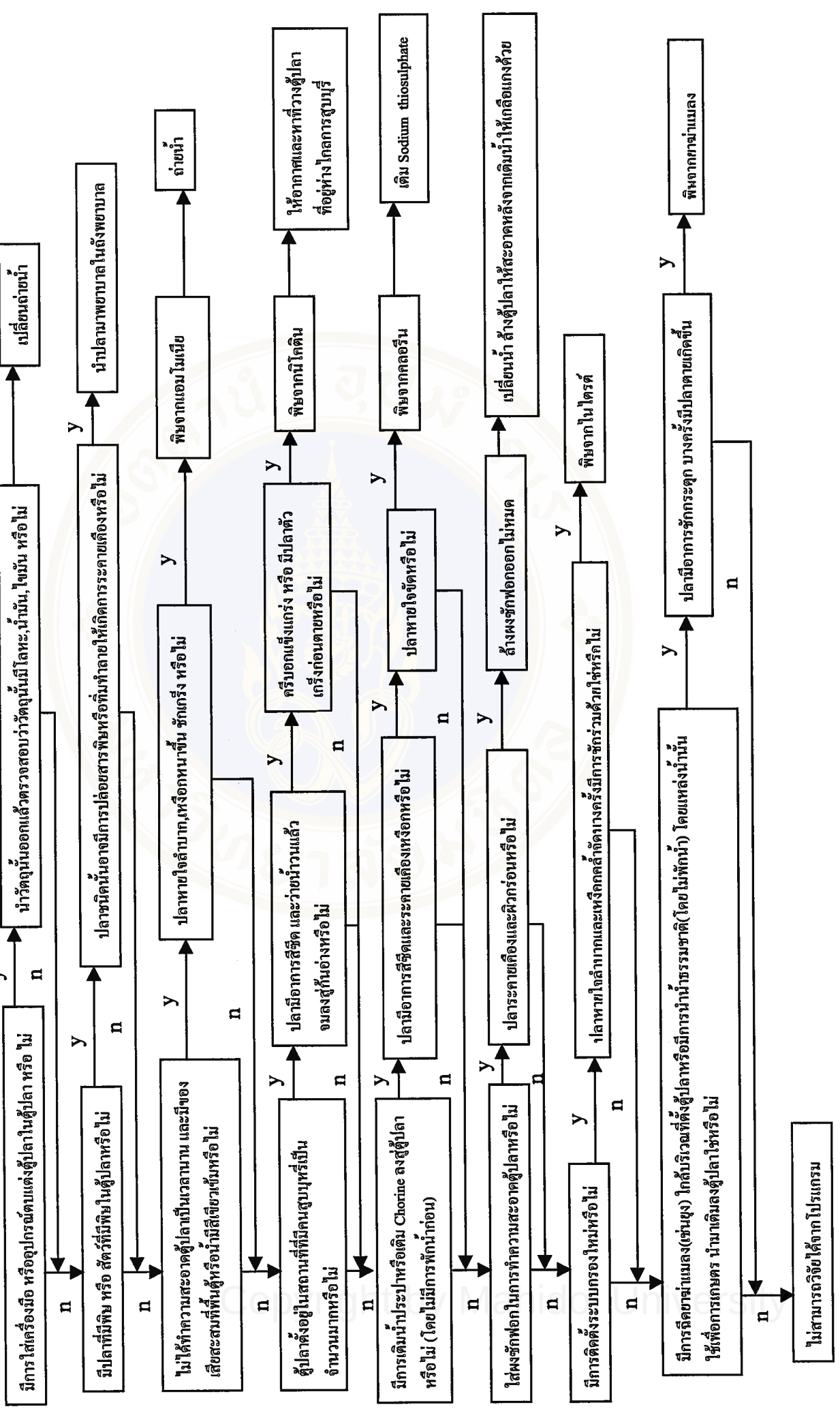


TOPIC : WATER PROBLEMS



TOPIC : FISH EYE PROBLEMS





APPENDIX D

EXAMPLE OF PROGRAM CODING

```
procedure TFormW2.SpeedButton1Click(Sender: TObject);
var
   out_str : string ;
   logic_ph,logic_t,logic_o,logic_co,logic_am,logic_ni1,logic_ni2,logic_sh : boolean ;
begin
   FormControl.Enabled := false ;
   if edit1.Text = '' then
      begin
         logic_ph := True ;
      end
   else
   if ((strtofloat(edit1.Text) >= 7.8) and (strtofloat(edit1.Text) <= 8.5))then
      begin
         logic_ph := True ;
      end
   else
      begin
         logic_ph := False ;
      end ;
   if edit2.Text = '' then
      begin
         logic_o := True ;
      end
   else
   if (strtofloat(edit2.Text) >= 4 )then
      begin
         logic_o := True ;
      end
   else
      begin
         logic_o := False ;
      end ;
   if edit3.Text = '' then
      begin
         logic_co := True ;
      end
   else
```

```
if (strtofloat(edit3.Text) <= 5 )then
    begin
        logic_co := True ;
    end
else
    begin
        logic_co := False ;
    end ;
if edit4.Text = '' then
    begin
        logic_am := True ;
    end
else
if (strtofloat(edit4.Text) <= 0.01)then
    begin
        logic_am := True ;
    end
else
    begin
        logic_am := False ;
    end ;
if edit5.Text = '' then
    begin
        logic_ni1 := True ;
    end
else
if (strtofloat(edit5.Text) <=0.01 )then
    begin
        logic_ni1 := True ;
    end
else
    begin
        logic_ni1 := False ;
    end ;
if edit6.Text = '' then
    begin
        logic_ni2 := True ;
    end
else
if (strtofloat(edit6.Text) <= 1 )then
    begin
        logic_ni2 := True ;
    end
else
    begin
        logic_ni2 := False ;
    end ;
```

```
  if edit7.Text = '' then
     begin
        logic_sh := True ;
     end
  else
  if (strtofloat(edit7.Text) <= 0.3 )then
     begin
        logic_sh := True ;
     end
  else
     begin
        logic_sh := False ;
     end ;
  if edit8.Text = '' then
     begin
        logic_t := True ;
     end
  else
  if ((strtofloat(edit8.Text) >= 18 ) and (strtofloat(edit8.Text) <= 32 )) then
     begin
        logic_t := True ;
     end
  else
     begin
        logic_t := False ;
     end ;
  out_str := '' ;

  if ((edit1.Text = '') and (edit2.Text = '') and (edit3.Text = '') and (edit8.Text= ''))
then
     begin
       out_str := 'ข้อมูลไม่เพียงพอสำหรับการวินิจฉัย ' ;
     end
  else
  if (logic_am and logic_co and logic_ni1 and logic_ni2 and logic_o and logic_ph
and logic_sh and logic_t)  then
     begin
        out_str := 'คุณภาพน้ำเหมาะสำหรับการเลี้ยงและควรหมั่นดูแลความสะอาดในตู้อยู่เสมอ
และควรตรวจวัดคุณภาพน้ำให้ครบทุกตัว ' ;
     end
  else
```

```
  if (logic_am and logic_co and logic_ni1 and logic_ni2 and logic_o and logic_ph
and logic_sh and (not logic_t))  then
      begin
        out_str := 'คุณภาพน้ำกำลังเกิดปัญหา เกี่ยวกับอุณหภูมิ ควรทำการเปลี่ยนถ่ายน้ำ และ
ควรตรวจวัดคุณภาพน้ำให้ครบทุกตัว' ;
      end
  else
  if (logic_am and logic_co and logic_ni1 and logic_ni2 and logic_o and
(not logic_ph) and logic_sh and logic_t)  then
      begin
        out_str := 'คุณภาพน้ำกำลังเกิดปัญหา เกี่ยวกับความเป็นกรดเป็นด่าง ควรทำการเปลี่ยน
ถ่ายน้ำ และควรตรวจวัดคุณภาพน้ำให้ครบทุกตัว' ;
      end
  else
  if (logic_am and logic_co and logic_ni1 and logic_ni2 and (not logic_o) and
(logic_ph) and logic_sh and logic_t)  then
      begin
        out_str := 'คุณภาพน้ำกำลังเกิดปัญหา เกี่ยวกับระดับความเข้มข้นของอ๊อกซิเจนในน้ำไม่
เหมาะสม ควรเพิ่มการให้อากาศ และควรตรวจวัดคุณภาพน้ำให้ครบทุกตัว' ;
      end
  else
  if (logic_am and (not logic_co) and logic_ni1 and logic_ni2 and logic_o and
( logic_ph) and logic_sh and logic_t)  then
      begin
        out_str := 'คุณภาพน้ำกำลังเกิดปัญหา เกี่ยวกับระดับความเข้มข้นของคาร์บอนไดอ๊อก
ไซด์ในน้ำไม่เหมาะสม ควรเพิ่มการให้อากาศ และควรตรวจวัดคุณภาพน้ำให้ครบทุกตัว' ;
      end
  else
  if ((not logic_am) and logic_co and logic_ni1 and logic_ni2 and logic_o and
( logic_ph) and logic_sh and logic_t)  then
      begin
        out_str := 'คุณภาพน้ำกำลังเกิดปัญหา เกี่ยวกับระดับความเข้มข้นของแอมโมเนียในน้ำ
ไม่เหมาะสม ควรทำการเปลี่ยนถ่ายน้ำ และ เพิ่มการให้อากาศ และควรตรวจวัดคุณภาพน้ำให้ครบ
ทุกตัว' ;
      end
  else
```

```
   if (logic_am and logic_co and ( not logic_ni1) and logic_ni2 and logic_o and
( logic_ph) and logic_sh and logic_t)  then
       begin
          out_str := 'คุณภาพน้ำกำลังเกิดปัญหา เกี่ยวกับระดับความเข้มข้นของไนไตรต์ในน้ำไม่
เหมาะสม ควรทำการเปลี่ยนถ่ายน้ำ เพิ่มการให้อากาศ และควบคุมการให้อาหารไม่ให้มากเกินไป
และควรตรวจวัดคุณภาพน้ำให้ครบทุกตัว' ;
       end
   else
   if (logic_am and logic_co and logic_ni1 and (not logic_ni2) and logic_o and
( logic_ph) and logic_sh and logic_t)  then
       begin
          out_str := 'คุณภาพน้ำกำลังเกิดปัญหา เกี่ยวกับระดับความเข้มข้นของไนเตรตในน้ำไม่
เหมาะสม ควรทำการเปลี่ยนถ่ายน้ำ เพิ่มการให้อากาศ และเปลี่ยนถ่ายน้ำ และควรตรวจวัดคุณภาพ
น้ำให้ครบทุกตัว' ;
       end
   else
   if (logic_am and logic_co and logic_ni1 and logic_ni2 and logic_o and logic_ph
and (not logic_sh) and logic_t)  then
       begin
          out_str := 'คุณภาพน้ำกำลังเกิดปัญหา เกี่ยวกับระดับความเข้มข้นของไฮโดรเจนซัลไฟด์
ในน้ำไม่เหมาะสม ควรทำความสะอาดตู้ปลาโดยเฉพาะบริเวณพื้นตู้และระวังไม่ให้มีการสะสมของ
เสียในบริเวณดังกล่าว และควรตรวจวัดคุณภาพน้ำให้ครบทุกตัว' ;
       end
  else
       begin
          out_str := 'คุณภาพน้ำกำลังเกิดปัญหา ควรเปลี่ยนถ่ายน้ำ เพิ่มการให้อากาศ และหมั่นดู
แลรักษาความสะอาดภายในตู้ ' ;
       end ;
```

BIOGRAPHY

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