Computer Simulation Based on K-Means as Learning Media to Determine Syndrome of Disease in Traditional Chinese Medicine

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WORD COUNT	5004	TIME SUBMITTED	15-AUG-2019 10:57PM
		PAPER ID	49564865

Computer Simulation Based on K-Means as Learning Media to Determine Syndrome of Disease in Traditional Chinese Medicine

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Abstract

Computer simulation based on Artificial Intelligence has been used in many aspects to help and solve the problem of people. In education aspect, Artificial Intelligence is used as a learning media also develops rapidly. The form of learning media such as intelligent agent, intelligent tutorial system, games serious. The use of learning media is based on the needs of students who want to learn. In Indonesia, acupuncture has become one of the alternative medicines in addition to conventional medical treatment. The problem that exist during learn acupuncture such as: taking time long enough to learn it, needing some experiences to be able to understand appropriately a syndrome disease that appear from a patient. K-means as one of the methods of Artificial Intelligence has the ability to cluster properly. Its ability is used to calculate the nearest centroid of the patient's symptoms in order to determine a disease syndrome of the patient.

Keywords: *K-means, Computer Simulation, Learning Media, Artificial Intelligence, database*

1. Introduction

Nowadays, the number of the growth of the use of computer technology so rapidly. Almost all aspects of human life are now coming into contact with the computer technology. Similarly, in the field of education, the use of computer technology also develops significantly. The significant progress in the use of computers is to develop learning media based on computer that are used teacher to teach the students. One manifestation of computer technology that used for education is a computer simulation. Computer simulations can facilitate students in understanding and studying a wide range of learning materials / course, such as an automation concept in programming, driving skills, business management [1-4]. This is because the use of computer simulation instruction offer a more positive effect on students' learning than traditional instructional [1]. In addition, computer simulation can be used to save on training costs, security is more assured than directly real practice and improve one's ability to fulfill a competency [2].

Computer simulation as a learning media can be a simulation game. As we known, that the education domain is consisted of three domains such as: cognitive domain, affective domain and domain psychomotor. Therefore, simulation games/computers have the ability to be used to develop these three domains. In the cognitive domain and psychomotor, simulation game has several advantages such offers highly interactive and engaging user experience [5]. With these advantages, the student / player able to obtain experience and can repeat the simulation game. While for the affective domain, a simulation game can be used to assess children's social skills development [6]. Simulation games that used to train and to educate students are usually in the form of serious games [7-10]. According to [7] serious games have a valuable capability as a media for instruction as long as the teacher can develop to assess the impact of serious games learning and methods for competence and capability assessment. The use of serious games can also be used to investigate the motivational strategies and the assessment of learners 'motivation [8].

In Indonesia, acupuncture as a part of Traditional Chinese Medicine (TCM) has evolved significantly. This can be shown more and more the emergence of acupuncture treatment clinics and hospitals that provide acupuncture services. Acupuncture has become one of alternative treatment besides the conventional medicine treatment. Meanwhile, to learn acupuncture needs more time to study about theory and practice of TCM. As it is known, that theory and practice of TCM is very different if compared with medical of conventional. The problems in learning acupuncture is requires a long time and requires a lot of experience to be able to understand exactly syndrome disease that arises from a patient [11]. Motivated based on that problem, this research intends to develop a learning media that can help students to learn TCM easier and more clearly. Therefore, a computer-based instructional media is required that it can help simplify and accelerate the learning acupuncture.. This research uses k-means as one of the methods of Artificial Intelligence that has the ability to cluster properly [12-13]. The advantage of k-means is to calculate the shortest distance from the set of data which in the form of the patient's symptoms toward to disease syndrome. The results of these calculations are used in learning media in the form of computer simulations.

2. Materials and Methods

K-Means

Clustering is a method of grouping the data based on the size of the proximity or similarity between the data with other data. Grouping of the clusters must not be the same. Grouping on the clusters based on the proximity of characteristics of an existing data sample, one of them by using the distance formula Euclidean. Applications of this cluster method are very wide, for example, in the case identifying issues or even in the case of decision making does not always exactly the same but often tend to have similar [13].

One of the popular clustering algorithm is K-means. K-means algorithm is used to divide the data into several clusters. K-means algorithm receives input in the form data without the label. This is different from a supervised learning algorithm that receive input in the form of a vector $(x_1 , y_1) , (x_2 , y_2) , \ldots , (x_i , y_i)$, where x_i is data from data training and y_i is the class label for x_i.

On learning of K-means algorithm, the program computer classifies its data to be the input without knowing in advance the target class. This learning included in unsupervised learning. Input received is the data (object) and k clusters desired. Then, the K-means algorithm classifies data (object) into k clusters. On each cluster there is a central point (centroid) which represents its cluster. Pseudo code of K-means algorithm is as follows [12-13]:

```
Initialize m_i, i = 1,…,k, for example, to k random x^t
Repeat
        For all x^t in X
                b_i^t ← 1 if || x^t - m_i || = min_j || x^t - m_j ||
                b_i^t ← 0 otherwise
        For all m_i, i = 1,…,k
                m_i ← sum over t (b_i^t x^t) / sum over t (b_i^t)
Until m_i converge
```

Vector m contains a reference for mean sample of each cluster. x ref to each of the experimental data, and b containing the class label that estimated. While the k-means algorithm is as follows:

1. Select a number of K centroid point (m_i) randomly
2. Classify the data in order to form a number of K cluster with the centroid point (m_i) of each cluster, which the centroid point (m_i) which have been previously
3. Update centroid point value (m_i)
4. Repeat steps 2 and 3 until the value of the centroid point (m_i) is no longer changed

3. Research Methodology

This research develops a computer simulation as learning media to determine a syndrome of disease in TCM. As we know that computer simulation able to serve an estimated of reality that does not need the expense of real life or its risks. On learning of acupuncture, before practice in acupuncture clinic, the students should have mastered the knowledge in determining disease syndrome in patients. Whereas for real practice, this process will require a long time because there are some steps for the students to learn. At first, they only observe patients while treatment is done. Next step, the students interview the patient and write down the symptoms appear. Next step, after the students interview and write down the symptoms, they must analyze and determine the syndrome of disease. Afterwards, the experts (acupuncturist or acupuncture doctor) evaluate the analysis result of the syndrome determination of the students. If the students make mistakes in determining a syndrome of disease. Then, the students must repeat the step from the beginning. So this process is done repeatedly until the students are capable of determining a syndrome. This conventional process will need much time. After passing this step, the students can directly interview patient, determine a syndrome and make a set of treatment for the patient.

For that reason, a computer simulation is developed, so that students will learn and explore knowledge in determining disease syndrome. With computer-aided simulation, students will learn faster in determining a disease syndrome. This computer simulation uses k-means as clustering method that is used to determine a disease syndrome. The system of computer simulation is built as follows: the input data are in the form of a set of symptoms (Clinical Manifestation), the output data are a set of differentiating syndromes and k-means as the process has a duty to cluster the input data correlate with the output data. The type of symptoms and disease syndrome differentiations are based on the book Acupuncture Therapeutics [11]. The numbers of symptoms are as many as 205 types of symptoms and the numbers of disease syndromes are as many as 38 types of syndromes. As an example of one of the relationship between symptoms and syndromes are shown in Table 1. Table 1 shows the symptoms usually appear for the lung syndrome on the type of "invasion of the lungs by wind cold".

Table 1: Clinical Manifestation of lung syndrome with type invasion of the lungs by wind cold

Clinical Manifestation	Type of Lungs Syndrome Invasion of the lungs by wind cold
Chills	✓
Fever	✓
Absence of sweat	✓
Nasal discharge	✓
Cough	✓
Clear thin sputum	✓
White tongue coating	✓
Superficial pulse	✓
Tense pulse	✓
Headache	✓
General aching	✓

Data sheet of patients that come from the Academy of Acupuncture Surabaya (AAS) are used as data input for the system. This data sheet consists of a set of symptoms that appear from the patient. The symptoms are achieved through interviews with the expert of acupuncture toward the patient by using an instrument that consists of some sections such as: inspection, auscultation, anamnesa, and palpation. The number of the data sheet of the patients who used for this research as many as 109 data. Such data have been verified by the faculty of AAS. Furthermore, k-means is run to process the input data (symptoms) of the data output (syndrome). K-means will perform calculations based on the distance that is closest to the centroid. The calculation results are in the form of clusters of syndromes, that according to the symptoms of the syndrome that are inserted into the computer simulation system. Table 2 is an example to show that there are some symptoms that occur in patient number 1, on the type of syndrome number 5 can also appear in a patient number 4 on the type of syndrome 15. However, the symptoms in patient number 1, on the type of syndrome 5 do not appear in the patient

number 2 on the type of syndrome 38. K-means has the ability to cluster symptoms in order to determine the syndrome, according to the amount of data used.

Table 2: Design of input – output k-means

No Patient	Symptom Appear							Syndrome Type
	Symptom No 1	Symptom No 2	Symptom No 3	Symptom No 4	Symptom No 5	.....	Symptom No 205	
1	✓		✓		✓			S5
2		✓		✓			✓	S38
3	✓			✓			✓	S7
4		✓	✓		✓			S15
.								.
.								.
109	✓		✓	✓	✓			S24

Figure 1 shows a block diagram of the establishment of computer simulation based on k-means. As mentioned earlier, k-means constructed based on symptoms appear of the patients through the patient data sheets. Furthermore, clustering is done based on the symptoms appear so that can be calculated the closest distance among the disease syndromes. The database is used to store patient data and also to relate the selected syndrome to treatment methods, principles of treatment and therapeutic treatment point. By combining between k-means method and the database, it can be used to construct a computer simulation as a learning media in determining the disease syndrome in TCM .

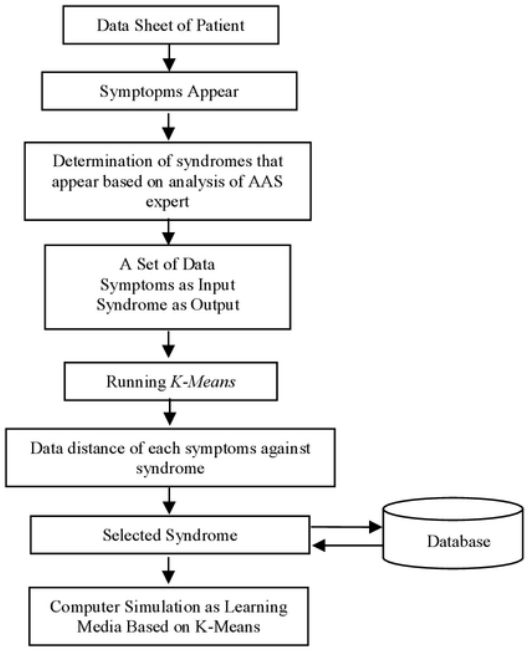


Figure 1. Block Diagram of Computer Simulation as Learning media

4. Result and Discussion

Implementation of computer simulation as a learning media is conducted through a learning scenario as shown in Figure 2. There are two scenarios using these learning media. The first scenario is to use a case study derived from textbooks and the second scenario using the interviews of the patient. Both scenarios aim to let users bring up the symptoms of the patient. Symptoms that arise are then put into learning media in the form of computer simulations that will calculate the shortest distance from a collection of symptoms against a disease syndrome. Then, computer simulations will bring up the calculation of the shortest distance between the symptoms of the disease syndrome. Calculation results of computer simulations are in the form of a ranking of the closest distance from the syndrome. The highest ranking of the closest distance becomes a decision in determining a disease syndrome. Furthermore, the computer system retrieves information about the principles of treatment, methods of treatment and therapy points of treatment that exist in the database in accordance with the selected disease syndromes.

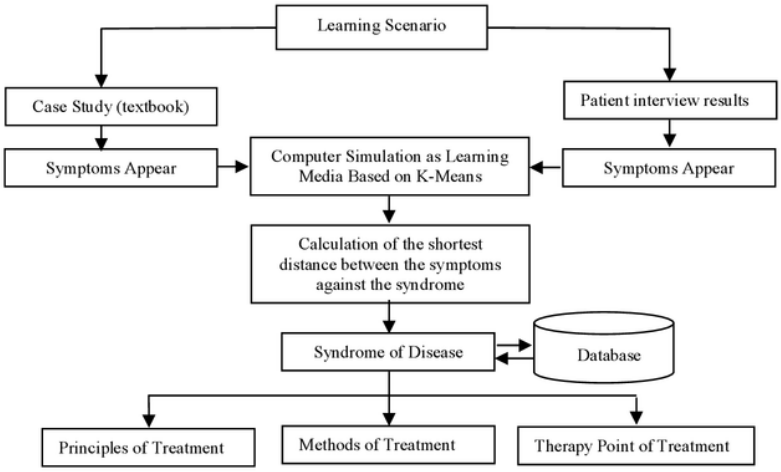


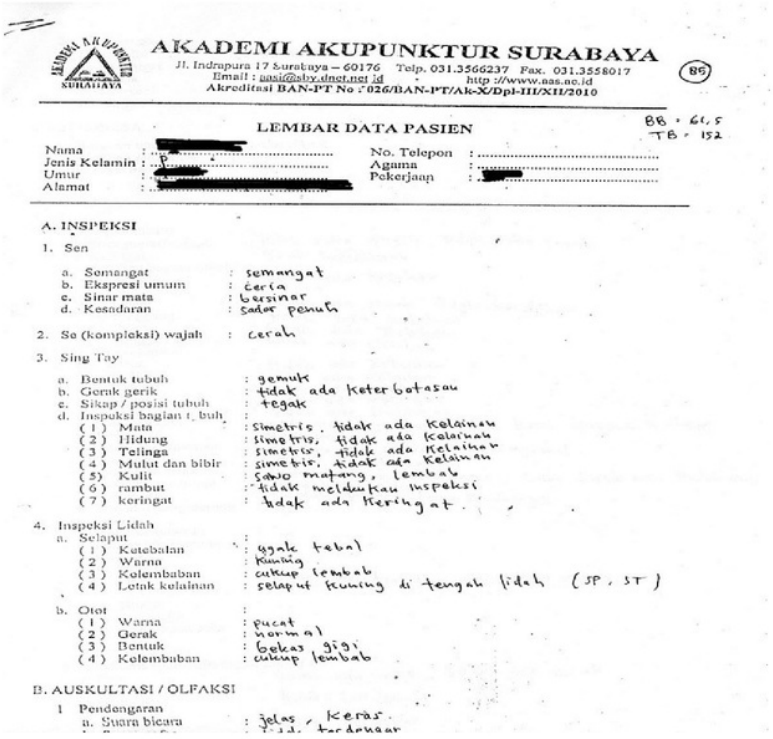
Figure 2. Block Diagram of Implementation of Computer Simulation as Learning media

The first scenario, it is intended for the students/users that they learn to recognize the symptoms of the patient. In this scenario, students learn about the patient case matter that given through an essay. Students must be able to write down all the symptoms that arise from the patient case matter. Then, the students write the results into the patient data sheet as seen in Figure 4.

Problem 1.
35-year-old woman suffering from pain in the epigastrium for 3 years, often nausea, vomiting.When she was late eating, then her stomach will pain. This is beginning to occur 3.5 years ago when her husband got married again, and rarely go home. Frequent bowel movements diarrhea. Looks rugae on the tongue and a thin membranous white. Since the husband remarries, he often angry. Often itchy skin, but often relieve by itself even if untreated
Problem 2.
Men aged 50 years complained of itching all over the body that does not disappear with medication. he suffered from hypertension, beside that he also quick to anger and frequently leg cramps.The whole skin black red blotches and small fester. Prior to this, he often sneezing and urticaria. he suffers from constipation, urinating less and yellow in color. He has deep pulse .
Problem 3.
30 years old woman complaining of headaches, especially in the back of the head.Sometimes she felt aching in the shoulder area. Headache since two years ago, feels relapse and no recurrence. Frequent feel stress since 2.5 years ago. Since then, she was quickly want to get angry.Defecation difficult if not eat fruits. Red tongue thick white membranous.Strong Pulse.

Figure 3. Examples of Study Case in Essay Model

After that students should analyze those symptoms based on TCM theory for determining the disease syndrome. Furthermore, the results of the determination syndrome from student analysis are compared with the results of the determination syndrome using computer simulations. Symptoms that have been identified by the students put into a computer simulation. Then, the computer simulation results are compared with the analyses of students on determination syndrome. It can be seen, whether the students are able to master the determination of the syndrome or whether they need to be learning again. Figure 3 shows examples of study cases in essay form [14].



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LEMBAR DATA PASIEN

BB : 61,5
TB : 152

Nama : [redacted] No. Telepon : .....
Jenis Kelamin : P Agama : .....
Umur : [redacted] Pekerjaan : [redacted]
Alamat : [redacted]

A. INSPEKSI

1. Sen
   a. Semangat : semangat
   b. Ekspresi umum : ceria
   c. Sinar mata : bersinar
   d. Kesadaran : sadar penuh
2. Se (kompleksi) wajah : cerah
3. Sing Tay
   a. Bentuk tubuh : gemuk
   b. Gerak gerik : tidak ada keterbatasan
   c. Sikap / posisi tubuh : tegak
   d. Inspeksi bagian tubuh :
      (1) Mata : simetris, tidak ada kelainan
      (2) Hidung : simetris, tidak ada kelainan
      (3) Telinga : simetris, tidak ada kelainan
      (4) Mulut dan bibir : simetris, tidak ada kelainan
      (5) Kulit : sawo matang, lembab
      (6) rambut : tidak melakukan inspeksi
      (7) keringat : tidak ada keringat.
4. Inspeksi Lidah
   a. Selaput :
      (1) Ketebalan : agak tebal
      (2) Warna : kuning
      (3) Kelembaban : cukup lembab
      (4) Letak kelainan : selaput kuning di tengah lidah (SP, ST)
   b. Otot :
      (1) Warna : pucat
      (2) Gerak : normal
      (3) Bentuk : bekas gigi
      (4) Kelembaban : cukup lembab

B. AUSKULTASI / OLFAKSI

1 Pendengaran
   a. Suara bicara : jelas, keras.

Figure 4. Patient Data Sheet from AAS

The second learning scenarios, it is intended to further lesson level. At this level, the students deal with patients directly and the students interview the patient. Then, the students write the interview results into the patient data sheet as seen in figure 4. Furthermore, the results of these interviews, the students concluded diagnosis disease syndrome of patients. To know the precisely the diagnosis, the students enter the symptoms that have been written on sheets of patient data into computer simulations. And then, the diagnosis can be known whether the student is in conformity with the results of computer simulations. Students can compare whether the diagnosis has correct or already been approached the rank of the resulting computer simulation. In this process, computer simulation teaches to the students how to determine disease syndrome. With the use of computer simulations, the teacher only acts as a facilitator who helps students in verifying the symptoms of the patients is in conformity or not during the interview session. If the students put in the symptoms in the simulation do not in accordance with the patient's condition, then automatically the simulation results also do not appropriate.

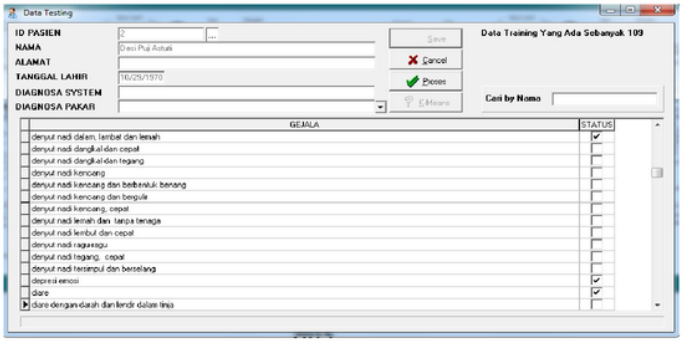

Figure 5. Data input for the patient

In the figure 4 shows patient data sheets. This sheet consists of 4 sections which consists of the inspection section, auscultation section, anamneses section and palpation section. The inspection section aims to examine the spirit of the patient, facial expressions, gestures, posture and tongue inspection. Auscultation section aims to examine the sound that comes from the patient, either of speech sounds, breath sounds, and cough sound. Anamnesis section aims to study about the pattern of the patient's life, such as eating patterns, sleep patterns, and emotional patterns. Palpation aims to examine the patient's perceived pain. Figure 5 shows a computer interface for the student. Students can fill patient data in order to it can be used as a medical record. By filling patient data, it can be used to monitor the development of treatment against the patient's illness. Hereinafter, students choose symptoms appear in a patient by clicking the tick marks on the display of the interface. Selected symptoms should match with the patient data sheets as a result from analyses from textbook case study (scenario 1) as well as the interview result from the patient (scenario 2). After symptoms have been given a tick, students can press "process button" to continue the process of determining the patient syndrome.

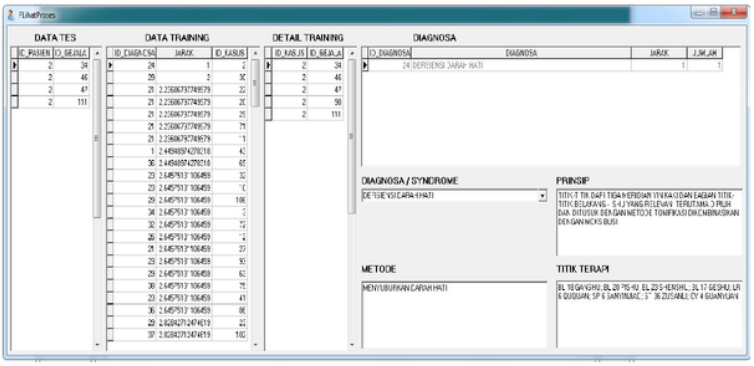

Figure 6. K-means results for the patient

An example of the results of computer simulations is shown in Figure 6. The results of computer simulation consist of test data, training data, detailed training, diagnosis, treatment methods, principles of treatment and therapeutic point of treatment. Data test consists of two parts, namely the ID data of the patient and selected symptoms of computer simulations. As seen in the figure, the patient ID data is number 2 with 4 selected symptoms with the numbers of symptoms are 34, 46,47 and 111. Data of diagnose training consists of an ID, distance and case ID that used to determine the shortest distance of

calculation result k means. Diagnostic results show the closest distance from the existing syndrome. For this example, that appears is a syndrome "liver blood deficiency". Methods of treatment refer to the chosen syndrome. Therefore, method of treatment to follow the syndrome. As well as with the principles of treatment and point of therapeutic treatment follows the syndrome. With a syndrome known then the computer can recommend treatment methods, principles of treatment and therapeutic treatment point.

Table 3: Comparison Expert versus Computer Simulation

No Patient	Symptoms Appear in data sheet patients	Syndrome Diagnosis	
		Experts	Computer Simulation
1	Weak forceless pulse, emotional depression, white tongue coating, a thick and sticky tongue coating, a pale tongue with white coating, palpitation, dizziness	Heart Qi Deficiency	Heart Qi Deficiency
2	The pulse is deep, slow and weak, emotional depression, diarrhea, a yellow tongue coating, numbness of the hand and foot	Stirring Of Liver Wind In The Interior	Stirring Of Liver Wind In The Interior
3	Weak forceless pulse, emotional depression, thirst with no desire to drink, white tongue coating, numbness the fingers	Hyperactivity Of Fire In The Stomach	Hyperactivity Of Fire In The Stomach
4	A thin yellow tongue coating, a red tongue with yellow coating, irritability	**Flare Up Of The Liver Fire**	**Retention of Cold in The Liver Meridian**
5	A deep and slow pulse, white tongue coating, enuresis, dream disturbed sleep, pale complexion, dull pain in the abdomen.	Consumption Of The Fluid Of The Large Intestine	Consumption Of The Fluid Of The Large Intestine
6	Weak forceless pulse, angina pectoris referring to the shoulder and arm, a pale tongue with white coating, pale complexion	Heart Qi Deficiency	Heart Qi Deficiency
7	A red tongue with little coating, dizziness, insomnia, dry throat and tongue, poor sleeping and memory, tinnitus, vertigo.	Kidney Yin Deficiency	Kidney Yin Deficiency
8	Irregular menstruation, emaciation, white tongue coating, weakness and soreness of the lower back, and knees	Kidney Yin Deficiency	Kidney Yin Deficiency
9	A deep and slow pulse, thirst with preference for cold drinks, a yellow tongue coating, a thin yellow tongue coating,	Hyperactivity Of Fire In The Stomach	Hyperactivity Of Fire In The Stomach
10	Emotional depression, white tongue coating, migraine, reduced appetite, epigastric and abdominal pain with cold sensation, palpitation	Excess Cold In The Stomach	Excess Cold In The Stomach
11	A white and slippery tongue coating, a red tongue, dizziness, headache, irritability	Hyperactivity Of Liver Yang	Hyperactivity Of Liver Yang
12	Amenorrhea or reduced menstrual flow, a pale tongue, pale complexion	**Liver Blood Deficiency**	**Hyperactivity of Gallbladder Fire**
13	Thirst with preference for cold drinks, general lassitude, a pale tongue with white coating, pale complexion, reduced appetite, abdominal distension	Spleen Qi Deficiency	Spleen Qi Deficiency
14	Dry cough without sputum, or with little, sticky sputum or with bloody sputum, emaciation, a red tongue lack of fluid, pale complexion, hoarse voice, absence of sweat	Lungs Yin Deficiency	Lungs Yin Deficiency
15	Spontaneous sweating, weak forceless pulse, general lassitude, a pale tongue with white coating, pale complexion, palpitation, dizziness	Heart Qi Deficiency	Heart Qi Deficiency
16	A pale tongue with white coating, pale complexion, reduced appetite, abdominal distension	Spleen Qi Deficiency	Spleen Qi Deficiency
17	A string-taut pulse, emotional depression, breast distension and pain	**Liver Qi Stagnation**	**Flare Up Of The Liver Fire**
18	Feeble cough, emotional depression, irregular menstruation, sticky tongue coating, white tongue coating, a pale tongue, pale complexion, shortness of breath, orthopnoea in severe cases	Lung Qi Deficiency	Lung Qi Deficiency
19	Chest fullness, a string-taut pulse, emotional depression, irregular menstruation, thirst, a thin yellow tongue coating, pale complexion	Liver Qi Stagnation	Liver Qi Stagnation
20	General lassitude, a pale tongue, numbness of the hand and foot, pale complexion, reduced appetite, abdominal distension	Spleen Qi Deficiency	Spleen Qi Deficiency

Table 3 shows the comparison between experts versus computer simulations. The comparison compares between diagnose results from experts and computer simulations to determine syndrome disease based on symptoms that appear from data sheet patients. The numbers of data sheet of patients are 20 data. The results show mostly the result of diagnose between experts and computer simulations is the same. Only 3 results are different between experts and computer simulation. The different results is happened, because computer simulations have difficulty to diagnose the syndrome disease if the numbers of symptoms are to less and the numbers of data training about the syndrome diseases also are less. Nevertheless, computer simulation still can diagnose syndrome disease. As we can see in Table 3 that computer simulation result is still in one criteria of organ syndrome. For example simulation number 4, the result is flare up of the liver fire against with retention of cold in the liver meridian both are still in the syndrome of liver organ. Simulation number 12, the result is a liver blood deficiency against with hyperactivity of gallbladder fire both are still in the syndrome of liver organ.

5. Conclusion

This research builds a computer simulation as a learning media that uses k- means clustering method and a database. K-means is constructed by using 109 pieces of patient data that has been verified the validity by experts of AAS. The symptoms are used to train k- means so that it can cluster the disease syndrome. Then, a database is used to store patient data and to store the calculation results of the closest distance in determining disease syndrome. Selected syndromes are related to methods of treatment, the principle of treatment and therapeutic point of treatment. This research is based on the symptoms that is inserted into the computer simulation.

The importance of the research is to accelerate students' understanding and to enhance students' knowledge of the disease syndrome in TCM. Because by using learning media in the form of computer simulations may help the understanding of students in the study of the disease syndrome in TCM easier and more clearly. It is can be compared, if students only learn case study through textbooks. Students will have difficulty in determining the actual disease syndrome. Because the main problem is students still need to have experience in determining disease syndrome. As it is known that in determining disease syndrome in TCM, it is needed a lot of experiences. Therefore, the significance of the research is by using computer simulation, the students able to increase their knowledge and experience.

6. Acknowledges

The authors would like to thank to The Department of Research and Technology Republic of Indonesian for financing this research through a grant competition for the second year (2015).

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14%

SIMILARITY INDEX

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