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Seismic Signal Noise Suppression Based on Improved VMD Algorithm

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Abstract: Seismic signals contain a variety of attributes, but different attributes are distributed in different frequency bands, so it is necessary to accurately decompose seismic signals into different frequency components, and carry out subsequent denoising processing more effectively. Variational modal decomposition is an effective method for analyzing non-stationary signals. Aiming at the problem of difficult parameter selection of unknown signals, a seismic signal denoising method based on the combination of variational modal decomposition based on quantum particle swarm optimization and Teager energy operator is proposed. The quantum particle swarm optimization algorithm makes the variational modal decomposition algorithm adaptively decompose the signal into eigenmodal functions of different frequency bands, which is convenient for subsequent filtering of signals with different frequencies. In the simulation experiment, the traditional time-frequency analysis method and this method were used to analyze and compare the synthetic signal. According to the comparison results of time-frequency diagram and spectrum diagram, the results show that this method is a more effective seismic signal denoising method..

Keywords: variational modal decomposition; Quantum particle swarm optimization; Seismic signal; parameter optimization; Singular spectrum analysis

1. INTRODUCTION

Seismic signal is an important source of information for oil and gas exploration. With the reduction of resources, seismic exploration is developing from areas with simple surface conditions to complex mountainous areas, carbonate rock exposure and other complex areas, and the detection target has become complex. Therefore, it is particularly important to eliminate the noise in seismic signal and improve the signal-to-noise ratio.

After Huang et al proposed Hilbert Huang transform (HHT)[1] in 1998, this method is widely used. The signal is decomposed into eigenmode components with different frequencies by empirical mode decomposition (EMD), and then Hilbert transform is performed on each eigenmode component to obtain the corresponding time spectrum of the signal. Dragomiretskiy et al. proposed an adaptive and completely non recursive modal variational and signal processing method - variational mode decomposition (VMD) [2] in 2014. By iteratively searching the optimal solution of variational mode, constantly updating each mode function and center frequency, K eigenmode functions (IMF) with certain bandwidth were obtained, and they were robust to sampling and noise. Wei Liu et al. proposed the use of VMD in seismic signal processing[3], obtained better processing effect compared with EMD and its changes EEMD, CEEMD and ICEEMD, and more effectively highlighted geological characteristics and stratigraphic information in the application of actual data. Liping Zhang et al. [4] proposed that after the seismic data was decomposed into a series of IMF by VMD, the high-frequency IMF was denoised by wavelet transform with soft threshold, and finally the denoised IMF and other IMF were reconstructed to obtain the denoised seismic signal.

However, Hilbert transform has its limitations. When extracting instantaneous frequency and other attributes, it is limited by Bedrosian theorem and Nuttall theorem, and there are some problems such as inaccuracy at both ends. The traditional VMD algorithm needs to subjectively determine the number of decomposed eigenmode components K and penalty factor alpha, so it is impossible to accurately select appropriate parameters when processing unknown signals. Traditional wavelet denoising depends on the selection of wavelet basis and discrete wavelet transform series. When dealing with unknown signals, it is impossible to accurately select wavelet basis and wavelet transform series through experience, which may lead to the removal of effective components of signals.

To solve these problems, this paper will use the quantum particle swarm optimization algorithm to adaptively optimize the parameters K and alpha of the variational modal decomposition algorithm, and then use the Teager energy operator to analyze the time-frequency of each processed seismic signal, which effectively increases the stability of the signal time spectrum. Finally, according to the correlation detection principle, the modal components whose correlation is lower than the threshold are denoised by singular spectrum analysis, so as to suppress the random noise of seismic signal.

2. PRINCIPLE

2.1 Quantum particle swarm optimization algorithm

Particle swarm optimization algorithm was first proposed by Eberhart and Kennedy in 1995[5]. The algorithm simulated the foraging behavior of bird groups. The solution of each optimization problem was regarded as a bird in the bird group. It was called "particle" in particle swarm optimization algorithm. The flight process of particle was the search process of the individual. Particle had two attributes of position and speed, The speed represented the moving speed,

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the position represented the moving direction, and the particle updated the position and speed in the iterative process to obtain the optimal solution of the optimization problem.

However, in particle swarm optimization algorithm, the particle motion speed is limited, which can not cover the whole solution space, and the convergence speed is slow. From the perspective of quantum mechanics, quantum behavior is applied to particle motion. In quantum mechanics, the motion state of particles with momentum and energy can be expressed by wave function. Therefore, in QPSO model, the wave function is used to represent the motion state of particles. According to Heisenberg uncertainty principle, the position and velocity of particles cannot be accurately measured at the same time. Therefore, QPSO algorithm cancels the moving direction attribute of particles, and the update of particle position has nothing to do with the previous movement of particles, which greatly increases the randomness of particle position, so it can basically cover the whole feasible solution space. The algorithm is usually performed using the following steps:

(1) Initialization: set the maximum number of iterations, the number of objective function arguments and the initial position of particles. Introducing average particle history optimal position: $\frac{1}{M}\sum_{i=1}^{M} P_{best\_i}$

Where M is the population number, P_{best_i} is the optimal position of the ith particle;

(2) Particle position update: the particle position update formula of quantum particle swarm optimization algorithm can be obtained according to particle swarm optimization algorithm: $P_i = \varphi \cdot P_{best\_i} + (1-\varphi) g_{best}$;

$x_i = P_i \pm \alpha |M_{best} - x_i| ln(\frac{1}{u})$

Where g_{best} is Optimal position of population, P_i updates the position to be used for the ith particle, φ Is the wave function of particles, x_i is the position of the ith particle.

2.2 Variational modal decomposition algorithm

Variational modal decomposition algorithm is a non recursive and adaptive signal decomposition algorithm. The algorithm can determine the number of modal decomposition as needed, and then adaptively match the optimal center frequency and limited bandwidth of each modal component. Therefore, it can effectively separate different frequency components in the signal without modal aliasing. The model of variational modal decomposition is established according to the variational problem with constraints. The variational problem is to ensure that after the original signal is decomposed into k components, each component has a limited bandwidth of the central frequency, and the sum of the estimated bandwidth of each mode is the smallest. The constraint problem is that the sum of all modal components is equal to the original signal, then the constrained variational problem can be expressed as

$$\min_{\{u_k\},\{\omega_k\}} \left\{ \sum_k \left\| \partial_t \left[(\delta(t) + \frac{j}{\pi t}) * u_k(t) \right] e^{-j\omega_k t} \right\|_2^2 \right\}$$

$$s.t. \sum_{k=1}^{K} u_k = f,$$

Where k is the number of modes to be decomposed, u_k is the k modal components by decompose, ω_k Is the center frequency of each mode, f is the seismic signal to be decomposed, $\delta(t)$ is the impact function.

In order to solve the constrained variational problem, a penalty factor is introduced α， The Lagrange multiplication operator $\lambda(t)$ can be used to reconstruct the constraint to obtain the augmented function expression:

$$L(\{u_k\},\{\omega_k\},\lambda) = 1K \left\| \partial_t \left[\left(\delta(t) + \frac{j}{\pi t} \right) * u_k(t) \right] e^{-j\omega_k t} \right\|_2^2$$

$$+ \left\| f(t) - \sum_{k=1}^{K} u_k(t) \right\|_2^2 + \langle \lambda(t), f(t) - \sum_{k=1}^{K} u_k(t) \rangle$$

The solution of the augmented Lagrange function is searched by the multiplication operator alternation method (ADMM), and the optimal solution is each eigenmode function in the frequency domain:

$$\hat{u}_k(\omega) = \frac{\hat{f}(\omega) - \sum_{i \neq k} \hat{u}_i(\omega) + (\hat{\lambda}(\omega)/2)}{1 + 2\alpha(\omega - \omega_k)^2}$$

However, the modal components decomposed by VMD algorithm rely on subjective judgment, and it is difficult to distinguish which component contains more information. Therefore, I propose to use correlation analysis to judge the signal that needs further noise elimination.

2.3 Singular spectrum analysis

Singular spectrum analysis is a method for processing nonlinear time series data, which can decompose trend, oscillation component and noise from time series. Its basic idea is to convert the observed time series data into its trajectory matrix:

Where L is the window length, Calculate XX^T and perform singular value decomposition. Let $S = XX^T$, λ_1, λ_2, ... , λ_L be the eigenvalue of S, and u be the standard orthogonal vector of matrix s. The singular value decomposition of trajectory matrix X can be solved as follows:

$X = X_1 + \cdots + X_d$, Where $X_i = \sqrt{\lambda_i} U_i V_i^T$

Then, the original time is divided into multiple disjoint groups, and the first n main components are formed into a new time series according to the demand to realize reconstruction, so as to remove the noise component in the original time series.

3. APPLICATION

Firstly, ordinary analog signal was used to verify the algorithm. The analog signal used four time series of different frequencies for superposition, and superimposes 5dB noise after synthesis. The analog signal is shown in Figure 1:

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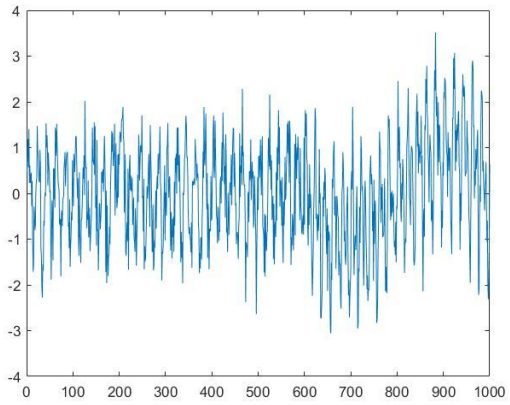


Figure 1.Analog signal

After denoising the signal using the algorithm in this paper, it can be seen from Figure 2 that the processed signal basically restores the frequency components and characteristics without noise.

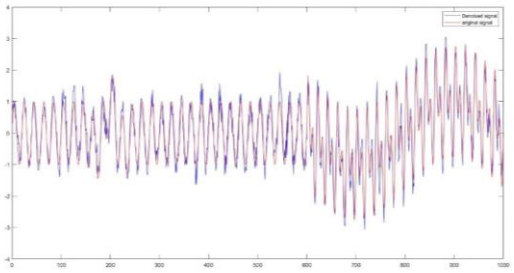
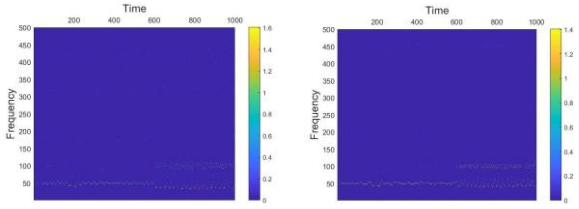


Figure 2.Contrast the denoised signal and the original signal

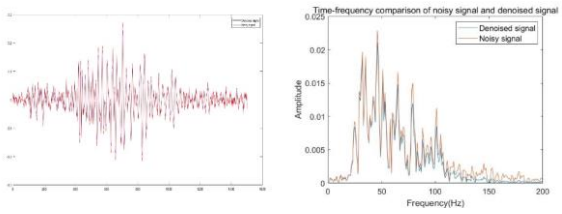
It can be seen from the time-frequency diagram before and after denoising in figure 3 that basically all high-frequency noise has been successfully filtered, and the original signal has been restored completely.



(a) (b)

Figure 3.Example of analog signal

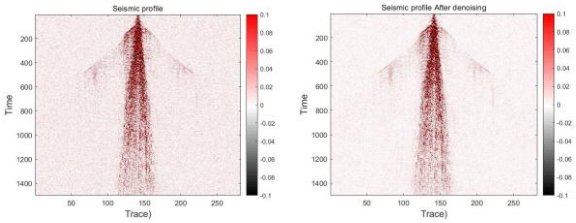
After that, 282 signals was intercepted from the actual seismic data, each signal had 1501 sampling points, and the sampling frequency was 2ms. We selected one of the signals for analysis. From its time domain image, we could see that the signal burr was significantly reduced after denoising, and then from the frequency comparison diagram, we could see that the high-frequency noise was effectively removed, and the original characteristics of the signal were not greatly affected.



(a) (b)

Figure 4.Example of Actual seismic signal

Next, we denoised the intercepted seismic profile. We could see that the denoised profile could more clearly observe subtle stratigraphic changes in figure 5, which was helpful for subsequent seismic interpretation such as seismic attribute extraction.



(a) (b)

Figure 5.Example of two dimensional seismic signal

4. CONCLUSION

The denoising method based on QPSOVMD-SSA proposed in this paper can effectively remove the high-frequency noise in the seismic signal. Firstly, the seismic signal was processed by QPSOVMD, and then the processed signal was denoised by the improved SSA method, so as to remove the noise in the seismic signal more effectively. This method separated signals of different frequencies, QPSOVMD the loss of low-frequency signals caused by traditional denoising methods, and the improved VMD algorithm could adaptively obtain the optimal parameters. This is reflected in both analog signals and actual signals, which proves that this method can better denoise seismic signals.

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Implementation of CBIR Method for Identification of Corn Disease Using Extreme Learning Machine

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Abstract: Various artificial neural network methods and digital image processing techniques have been applied in agriculture. Previous researchers have proposed methods for identification or detection of plant diseases, such as using K-NN, support vector machine (SVM), backpropagation and so on. The disease attack can reduce the amount of agricultural productivity and result in other material losses for farmers. Plant diseases can be observed from the physical and color changes of the affected parts such as roots, stems and leaves. However, with the development of computer vision technology, observations can be assisted by image processing methods and artificial neural networks, for automation in agriculture. This study proposes a method of applying digital image processing with artificial neural networks to identify corn plant diseases. The purpose of this research is as a comparative study of the proposed method with other conventional methods. The methods used are content based image retrieval (CBIR) and extreme learning machine (ELM). Content based image retrieval (CBIR) is the process of searching for an image in a database by comparing the features in the query image with the features that have been stored in the image database. Meanwhile, extreme learning machine (ELM) is an artificial neural network with one hidden layer or single hidden layer feedforward neural network (SLFNs). The feature extraction used consists of 3 features, namely color, shape, and texture feature extraction. The dataset consists of 3 types of images, namely images of healthy leaves, leaf spot disease, and rust disease. The ELM artificial neural network serves as a classifier that classifies the types of diseases based on the given feature extraction. The proposed system is able to identify the type of disease based on the pattern that appears on the leaf surface with the highest precision of 0.9922.

Keywords: Canny edge detection, Color moment, CBIR, Extreme learning machine, GLCM

1. INTRODUCTION

The need for corn in Indonesia as a staple food other than rice is increasing every year. Besides being used as a staple food, corn can also be processed into various other products such as corn flour, corn oil, animal feed ingredients and so on. One of the ways to meet national corn needs is to increase the productivity of corn plants. But on the other hand, diseases that attack corn plants can reduce corn productivity and cause other material losses. The disease can be observed from changes in leaves, roots, and stems. Diseased plants if not treated immediately can inhibit plant growth and eventually die.

Observations of corn plant diseases can be observed directly through the five senses, namely the human eye. However, with the development of digital image processing technology and artificial neural networks can help in the development of agricultural automation in the identification of plant diseases. The advantage of using an artificial neural network is that it can overcome the problem of classifying corn plant disease images based on patterns that appear on the leaf surface through a number of calculation processes during learning and the use of large datasets can recognize patterns relatively easily by making complex relationships between layers in the network based on training data. [1][2]. The artificial neural network will conduct training on a given image pattern to form a model and certain rules as a reference, then based on the training data it can be used to recognize the pattern given in the test based on the reference to the training [3].

Previous research has carried out identification of corn plant diseases through the image of infected leaves, such as identifying corn leaves that are infected with rust and differentiating them from healthy corn leaves. The method used is to use a morphological operation with a threshold based on area. Based on the proposed method, diseased leaves were able to accurately quantify the degree of damage caused by rust spots [4].

Further research in identifying corn plant diseases is to use the bag of features method and the support vector machine (SVM) algorithm. The leaf images used were 2,000 images which were processed using the bag of features (bof) method and histogram statistics based on texture features. Then classified with multiclass support vector machine (SVM). Based on this research, the proposed method is able to provide an accuracy of 83.7% in identifying corn plant diseases [5].

The next research is to classify images based on similarity of features using the bag of features (bof) method which can generate features automatically. The steps taken consist of 4 stages, namely the stage of feature point location, feature extraction, visual word grouping, and classification using a support vector machine (SVM). The images used are divided into 3 types of images, namely RGB, greyscale, and segmented images. Each type is divided into 4 image classes, namely healthy leaf images, cercospora, rust disease and leaf blight where each class consists of 50 images. The results of this study indicate an accuracy of 82% for RGB images, 77% for grayscale images and 85% for segmented images [6].

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Other researchers investigated the various uses of features in the classification of maize plant diseases. The features used are RGB color features, scale-invariant feature transform (SIFT), speeded up robust features (SURF), and Oriented FAST and rotated BRIEF (ORB). Performance evaluation of these features uses several machine learning algorithms such as support vector machines (SVM), Decision Tree (DT), Random forest (RF), and Naive Bayes (NB). With the number of image samples as many as 3,823 images which are divided into 4 classes of corn plant diseases. The evaluation results show that the use of RGB color features gives the best accuracy results in the classification of plant diseases [7].

The research proposed in this paper is to design a system using a combination of two methods, namely content based image retrieval (CBIR) and extreme learning machine (ELM) to identify corn plant diseases using the image of infected leaves. The proposed CBIR system uses three feature extraction methods, namely color feature extraction using color moment, texture feature extraction using gray level co-occurrence matrix (GLCM), and shape feature extraction using the canny edge detection method. While the ELM will function as a classifier that will determine the similarity of the two images between the query image and the image stored in the database.

2. METHOD

2.1 Color Moment

Color moment is a feature that can be used to distinguish images based on their color. The color distribution in an image can be interpreted as a probability distribution which is the basic assumption of the color moment. The calculation of the probability distribution used is the mean, standard deviation, and skewness [8].

A color space consists of three color components. For example, the RGB dimension space consists of three basic color components, namely Red (red), Green (green), and Blue (blue). Moment calculation is performed on each color component, so that it will produce nine moments as the identity of an image.

The HSV (hue, saturation, value) color space is a color space that represents the human senses of vision. The hue component represents the color, the saturation represents the level of color dominance, and the hue represents the brightness level, so this method can identify the color, the level of dominance and brightness. Hue values range from 0 – 360 degrees, with color variations ranging from red to yellow, green, cyan, blue, to return to red [9].

To get the value of the color moment feature extraction, it can be seen in the diagram shown in Figure 1 [10].

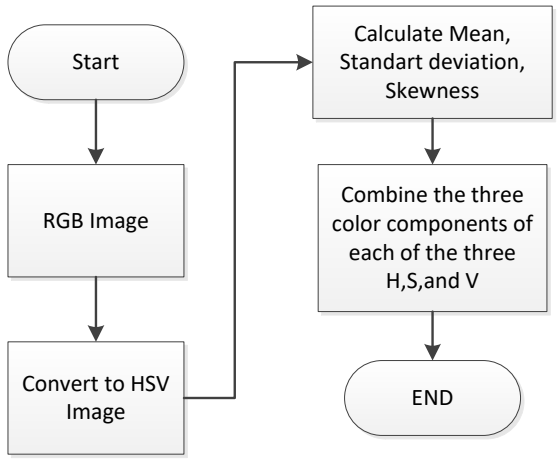

Figure 1. Color moment feature extraction flowchart

Calculation of color statistics on the color moment method to get the mean, standard deviation, and skewness is explained as follows [11]. The mean (mean) represents the distribution and is calculated using the equation:

$$\mu = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N} P_{ij} \quad (1)$$

The standard deviation is obtained from the square root of the variance which expresses the distribution area,

$$\sigma = \sqrt{\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(P_{ij} - \mu)^2} \quad (2)$$

Skewness or inclination is a measure of asymmetry, calculated using the equation:

$$\theta = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(P_{ij}-\mu)^3}{MN\sigma^3} \quad (3)$$

The data distribution will be skewed to the left if the skewness is negative, and vice versa. However, if the distribution is symmetrical, then the skewness coefficient will be zero.

2.2 Grey Level Co-occurrence Matrix (GLCM)

Haralick (1973) proposed a texture feature extraction method using a gray level co-occurrence matrix (GLCM) to explain partial patterns using 28 features. GLCM is calculated based on an order 2 matrix approach based on the relationship between pairs of two pixels in an image with a certain intensity, angle direction, and distance. The angles used in this method are 0º, 45º, 90º and 135º. Of the 28 features presented, only 14 features that can be used are angular second moment (ASM), contrast, correlation, variance, inverse different moment (IDM), sum average, sum variance, sum entropy, entropy, difference entropy, information measures correlation. 1 and 2, and the maximal correlation coefficient [12]. However, Newsam and Kammath in their journal propose using only 5 features in texture feature analysis using GLCM, namely angular second moment (ASM)/energy, contrast, inverse different moment (IDM)/homogeneity, entropy, and correlation [13].

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TABLE I
GLCM Feature Equation [14]

No.	Fitur	Persamaan
1.	Energy	$\sum_{i,j=0}^{N-1} P(i,j)^2$
2.	Contrast	$\sum_{i,j=0}^{N-1} P_{i,j}(i-j)^2$
3.	Homogeneity	$\sum_{i,j=0}^{N-1} \frac{P_{i,j}}{1+(i-j)^2}$
4.	Entropy	$\sum_{i,j=0}^{N-1} P_{i,j}(-lnP_{i,j})$
5.	Correlation	$\sum_{i,j=0}^{N-1} P_{i,j}\left[\frac{(i-\mu_i)(j-\mu_j)}{\sqrt{(\sigma_i^2)(\sigma_j^2)}}\right]$

Energy is the homogeneity value of an image. Contrast is the value of the variation of the gray level of pixels in an image. Entropy is a measure of the irregularity of the gray level in the image. And correlation is the value of the linear dependence between the gray level values in an image.

2.3 Canny Edge Detection

The canny edge detection method was first introduced in 1986 as an operator for edge detection based on optimization algorithms. The canny operator has three advantages and has become the standard for edge detection including :

- Better SNR (signal noise ratio) means that it is less possible to determine the edges and non-edges of an image, so that all edges can be detected properly.
- Better location performance, the detected edge is in the exact center of the edge or in the actual position.
- One edge corresponds to one response, one response to an actual edge [15].

The Canny algorithm consists of several steps, described in the form of a flowchart as follows [16]:

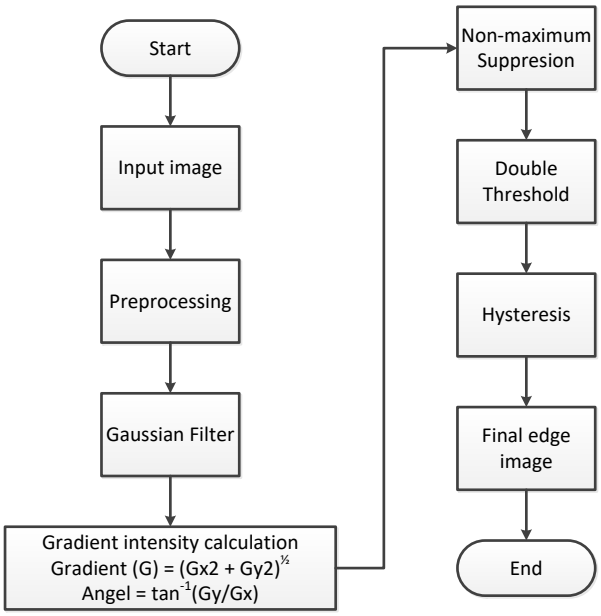

Figure 2. Canny edge detection feature extraction flowchart

1. Smoothing.

To reduce noise or smooth out an image, Canny uses a Gaussian filter with Eq.

$$H_{i,j} = \frac{1}{2\pi\sigma^2} e^{-\frac{(i-(k+1))^2+(j-(k+1))^2}{2\sigma^2}} \quad (4)$$

Di mana :

i,j : the filter coordinates on the x-axis and y-axis, respectively.

k : Gaussian kernel size

σ (sigma) : standard deviation

2. Finding gradients magnitude and direction.

The magnitude of the gradients magnitude is determined by the equation:

$$G = \sqrt{G_x{}^2 + G_y{}^2} \quad (5)$$

Sedangkan, nilai sudut (direction) di hitung dengan menggunakan persamaan :

$$\theta = tan^{-1}\left(\frac{G_x}{G_y}\right) \quad (6)$$

G_x is the first derivative of the component on the horizontal axis, and G_y is the first derivative of the component on the vertical axis. Value of G_x and G_y ditentukan menggunakan masking berikut.

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1	0	-1
1	0	-1
1	0	-1

(a)

1	1	1
0	0	0
-1	-1	-1

(b)

Figure 3. Derivative masking (a) G_x and (b) G_y

3. Non-maximum suppression

This step is to localize the edges precisely. For that each pixel will be checked whether it is the edge of the maximum value in the surrounding local area. If the value of a pixel is the maximum value, it will be retained. On the other hand, if the pixel value is lower, it will be converted to a zero value. The value of the gradient is determined based on the direction of the angle which is divided into 4 groups [17]:

a. Horizontal with direction in the range (-22.5º, 22.5º) or (-157.5º, 157.5º)

b. Vertical with direction in the range (-112.5º, -67.5º) or (112.5º, 67.5º)

c. +45, with directions between (-67.5º, -22.5º) or (112.5º, 157.5º)

d. -45, with directions between (-157.5º, 112.5º) or (22.5º, 67.5º)

The illustration of the direction of the corner above is shown in Figure 4.

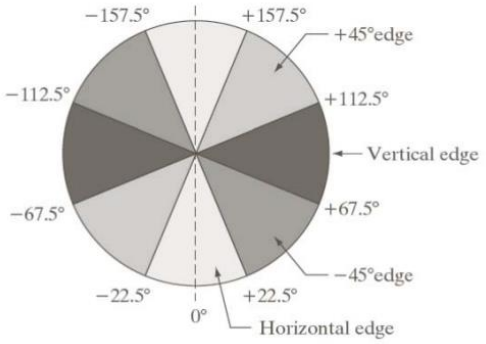

Figure 4. Range of angle direction of non-maximum suppression

4. Double thresholding

Potential edges are determined using thresholding, this is done to reduce the number of non-edge edges in the image. Thresholding consists of two T1 (upper limit) and T2 (lower limit). Edges with values > T1 are strong edges. Edge values that are between T2 and T1 are weak edges. Meanwhile, values below the T1 threshold will be deleted.

5. Edge tracking by hysteresis thresholding.

Determination of the edge of the image is done based on its connectivity. If it is connected to a strong edge it is considered an edge, otherwise it is deleted [18].

2.4 Content Based Image Retrieval (CBIR)

Image retrieval (image retrieval) is the process of searching for an image with an input (query) in the form of an image. Specifically known as content based image retrieval (CBIR). This method was first proposed by Kato in 1992.

This method consists of two steps, namely feature extraction and feature matching. The features contained in the image will be extracted and stored in the database. The features used can be a single feature or more than one feature [19]. To get these features, the preprocessing stage is carried out by converting color and changing the image size. Furthermore, feature extraction is carried out in the form of color, shape, and texture features.

The content based image retrieval method can be described in the form of a flow chart as shown in Figure 5 [20].

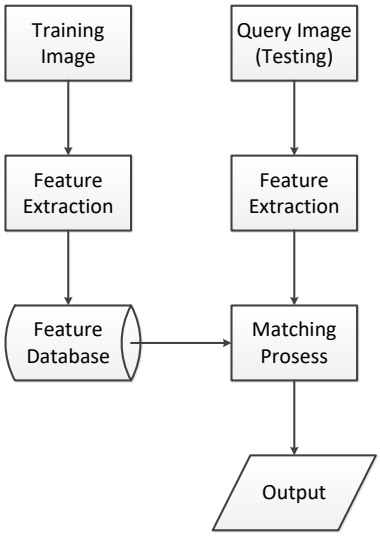

Figure 5. CBIR Flowchart

Determination of similarity between two images is done by calculating the feature distance. Distance is a common approach used for image search. Its function is to get the similarity between two features. The features obtained from the extraction of the query image are compared with those that have been stored in the database. The image with the closest distance is an image similar to the query image [21].

The use of the CBIR method is able to increase accuracy in image search when compared to text-based using keywords. The CBIR method is able to extract low-level image features automatically and measure image similarity by comparing features. Color, texture, and shape features are low-level features that are useful in representing and comparing images automatically [22].

2.5 Extreme Learning Machine (ELM)

Extreme learning machine (ELM) is a feedforward artificial neural network with a single hidden layer feedforward network (SLFNs). This algorithm was first proposed by Huang (2004) [23]. Generally, in other feedforward neural networks in order to produce high performance, the parameters used such as threshold values, weights, and activation functions must be appropriate to the system used. By using a gradient-based approach, all these parameters are changed iteratively resulting in low performance because they are trapped in the local minima.

In contrast to gradient-based ANN (artificial neural network), the use of input weights in the ELM algorithm is chosen randomly while the output weights are calculated analytically, so as to reduce the completion time and error values trapped

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in the local minima. This can improve the performance results of the ELM algorithm. The activation functions that can be used in ELM are linear and non-linear functions (sigmoid, sine, gaussian), and discrete or non-derivable functions [24].

The ELM method has been applied in the field of classification and researchers have obtained better and faster learning and generalization performance results compared to other gradient-based methods such as backpropagation. There are two parameters that need to be tested in using ELM as a classifier, namely the number of hidden neurons (N) and the activation function (F) [25].

SLFN with L hidden nodes can be represented by the following equation [26]:

$$f_L(x) = (\sum_{i=1}^{L} G_i(x, a_i, b_i) \cdot \beta_i, \quad a_i \in R^d, b_i, \beta_i \in R \tag{7}$$

$$G_i(x, a_i, b_i) = g(a_i \cdot x + b_i) \tag{8}$$

$G_i(\cdot)$ is the activation function at the i-th hidden node. a_i is the input weight vector that connects the input layer to the i-th hidden layer. b_i is the bias weight of the i-th hidden layer. β_i is the output weight.

Equation (7) above can be simplified into the following equation:

$$\beta = H^{\dagger} T \tag{9}$$

$T = [t_1, \ldots, t_N]^T$. $H^{\dagger}$ is the inverse Moore-Penrose matrix **H**. Thus, the calculation of the output weight can be carried out by means of a mathematical transformation, to avoid lengthy training where the parameters are adjusted iteratively with several appropriate training parameters [27].

The ELM algorithm can be briefly explained as follows :

1) Randomly assign hidden node parameters. For example for input weight a_i and bias b_i. i = 1,…,L
2) Calculate the hidden layer output matrix **H**.
3) Calculate the output weight vector with equation (9).

3. PROPOSED SYSTEM

The CBIR system consists of two stages, namely the training and testing stages. The training phase consists of the configuration of the neural network responsible for studying the features of the extracted image, the learning process is carried out using the ELM algorithm. Furthermore, the network stores the rules that have been learned in the database. The rules are made for comparison and decision making. The comparison is done by comparing the query image with the image that has been stored in the database at the training stage. The neural network makes decisions according to the similarity between the two features of the query image and the database.

The testing stage is the stage in the image query. The image to be entered is first carried out in the preprocessing and feature extraction stages. At this stage the ELM network acts as a selective classifier in determining the image that is most similar to the image stored in the database. So that it can identify accurate and similar images efficiently according to the image query given [28].

The initial stage before the training and testing process is carried out in the initial stages of basic image processing for all images, both on training images and test images. The preprocessing stage is done with color conversion, and image resizing. Then the next step is feature extraction in the form of color, texture, and shape features. Color extraction is done by using a color moment. Color feature extraction is obtained by converting the image in RGB space to HSV and then performing statistical calculations such as mean, standard deviation, and skewness. Texture feature extraction was obtained using the gray level co-occurrence matrix (GLCM) method. The features used consist of angular second moment (ASM), contrast, inverse different moment (IDM), entropy, and correlation. The shape features are obtained by edge detection using the canny edge detection method.

The following is a block diagram of the proposed research procedure.

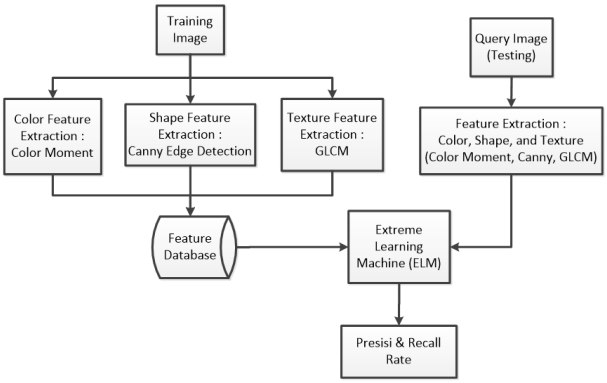

Figure 6. Flowchart of the proposed research.

4. RESULT AND DISCUSSION

The dataset used is secondary data obtained from https://github.com/charul97/Plant-disease-detection [29]. The dataset consists of 3 image categories, namely healthy leaves, common rust and leaf spot disease (cercospora). Figure 7 is an example of the image used.

a. Common rust b. Cercospora c. Healthy

Figure 7. Example of image dataset

The amount of data is divided into 2 parts, namely training data as many as 800 images and test data as many as 400 images.

Table III

The value of precision and recall of system test results

Activation function		Number of Hidden Nodes							
		25	50	75	100	125	150	175	200
Tanh	**Precision**	0.9663	0.9786	0.9754	0.9732	0.9795	0.9834	0.9836	0.9699
	Recall	0.9611	0.9678	0.9744	0.9778	0.9833	0.9833	0.9778	0.9689
Sine	**Precision**	0.7634	0.8851	0.9196	0.9363	0.9323	0.9326	0.9475	0.942
	Recall	0.7489	0.8833	0.9244	0.9344	0.9311	0.9333	0.9456	0.9467
Tribas	**Precision**	0.8253	0.9159	0.9086	0.9275	0.9544	0.9657	0.9576	0.9663
	Recall	0.8267	0.9133	0.91	0.9244	0.9467	0.9644	0.9544	0.9589
Hardlim	**Precision**	0.8195	0.9052	0.9274	0.9358	0.9559	0.9442	0.9441	0.9268
	Recall	0.8189	0.9	0.9289	0.9322	0.9567	0.9422	0.9456	0.9244
Rbf	**Precision**	0.9922	0.9912	0.9845	0.966	0.9606	0.9369	0.9298	0.9429
	Recall	0.9911	0.9922	0.9822	0.96	0.9556	0.9344	0.9233	0.9411

The input image (query) given in the form of an RGB image is carried out in a preprocessing stage in the form of conversion to gray scale, resizing and rescale then the feature extraction process using color moment, GLCM, and canny edge detection. The ELM classifier will compare the features that have been extracted in the database with the input image (query) and determine the type of disease based on its features.

The system for identifying corn plant diseases was made using the python programming language and using the google collaborative application. System testing is done by changing the value of the hidden node by using five types of activation functions as a comparison of the level of precision. The number of hidden nodes used ranges from 25 - 200 hidden nodes, while the types of activation functions consist of 5 types, namely hyperbolic tangent (tanh), sine, triangular basis (tribas), hard limit (hardlim), and radial basis function (Rbf). Meanwhile, for feature extraction using GLCM, the angle used is 45o with a neighboring distance of 1 pixel.

Effective performance measurement is needed as an evaluation of the algorithm used in designing the image retrieval application. The performance measurement of the CBIR system can be known through the level of precision and recall rate based on the truth table.

Precision is a comparison of the number of images that are really relevant. A good precision is worth 1.0. Precision can be calculated using equation (10):

$$Precision = \frac{True\ Positive\ (TP)}{True\ Positive\ (TP) + False\ Positive\ (FP)} \quad (10)$$

Recall rate is the ability of the system to select all images that have true values and not select images that have false negative values. The recall rate can be calculated using equation (11):

$$Recall = \frac{True\ positive\ (TP)}{True\ Positive\ (TP) + False\ Negative\ (FN)} \quad (11)$$

The first experiment was carried out using 25 hidden nodes with an activation function of the radial basis function (rbf), the results of the system test using the truth table as shown in Table II.

TABLE II
Truth Table System Test Results

Actual	Prediction		
	Cercos	***Healthy***	***Rust***
Cercospora	98	2	0
Healthy	1	149	0
Common rust	0	0	150

In Table II above, the system has succeeded in identifying 150 common rust images, 98 images of leaf spot disease (cercospora) and 2 images identified as healthy leaf images. As for healthy leaf images, the system was able to identify 149 images and 1 image was identified as leaf spot disease (cercos).

The values in table II above are the number of images that have been identified by the system according to their respective classes, namely images of healthy leaves (healthy), leaf spot disease (cercospora), and rust disease (common rust), then by testing using five types of functions. Different activation and number of hidden nodes in each test with a value range of 25 - 200 hidden nodes obtained precision and recall values as shown in Table III.

Based on Table III above, it is known that the precision value of the system is in the range of values between 0.7634 – 0.9922. While the recall value is in the range of 0.7489 – 0.9922. The best precision value among all tests is 0.9922 and the recall is 0.9911 using the radial basis function (Rbf) activation function with a total of 25 hidden nodes. In Table III it also appears that the precision value of the test with the tanh function shows a value that tends to be stable when compared to the rbf function which has decreased in the use of the 200 hidden nodes. This could be due to changes in the structure of the parameters used by machine learning which resulted in overfitting or underfitting resulting in fluctuating changes in value.

If with the addition of the structure, the value becomes high, then the system is underfitting. On the other hand, if the addition of the value structure becomes low, then the system is overfitting. Therefore, the extreme learning machine algorithm needs to adjust the parameters used in each test, so that the best value is obtained [30]. Based on Table III, the average value of the activation function can be seen in Figure 8.

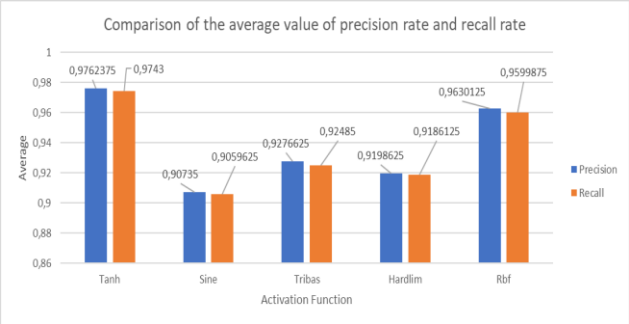

Figure 8. Comparison of the average precision and recall rate

Figure 8 shows the comparison of the average number of system precision and recall rate. In the graph, it can be seen that the Tanh function gives a higher average result than the other activation functions. However, testing using the radial basis function (rbf) with 25 hidden nodes gave the highest results compared to testing using the tanh activation function.

5. CONCLUSION

A plant disease identification system using content based image retrieval (CBIR) and extreme learning machine (ELM) algorithms has been carried out. The dataset used is an image of leaves affected by rust and leaf spot disease, as well as leaves that are not affected by the disease. Based on the results of testing the proposed system, the activation function of the radial basis function (rb) and the number of hidden nodes 25 gave the highest results compared to the other four types of activation functions, namely hyperbolic tangent (tanh), sine, triangular basis (tribas), and hard limit (hardlim).). The system is able to identify the type of corn plant disease with a precision level of 0.9922. This is supported by the use of three types of feature extraction, namely color, shape, and texture features in recognizing types of corn plant diseases using the image retrieval method and classified by the extreme learning machine algorithm. Further research needs to be tested with the addition of other types of plant diseases and different datasets. Also, optimization with certain methods so that a stable precision value is obtained in each test.

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A Systematic Review on Usability Evaluation for University Websites

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Abstract: Usability of websites has been studied severally in a general term in different sectors such as entertainment, social media and e-commerce. Higher education is a sector that needs more attention because Universities are very important in the society and their websites hold important information for prospective students, parents, faculty, students of the university and the public. Several literature reviews have been conducted on website usability evaluation, not many have focused on University website usability evaluation. Existing reviews of University website usability evaluation have based their review on certain aspect of usability evaluation such as the methods used. The objective of this study is to carry out a systematic literature review of recent studies in this area in order to provide insight for University website developer, usability researchers and higher academic institutions in all. This study focuses on researches conducted on University website usability evaluation from 2016 to 2021. Findings from this study include additional information different from existing literature review, such as, objectives of researches, common usability attributes used by usability researchers, methods of data collection and analysis, changes in data collection due to Covid-19 pandemic and the types of usability problems found. The commonly mentioned usability problems are problems related to interface design, content, navigation, performance and accessibility.

Keywords: *University website, usability evaluation, user experience, human computer interaction*

1. INTRODUCTION

The Internet has evolved rapidly and turned into a medium for worldwide communication. Website is part of the Internet that provides the ability for individuals and organizations to share information with their users and it has become inevitable for businesses that want to stay competitive in the Covid-19 era. Having a website has become vital for Universities [1] as it is an interface to provide information to students, faculty, prospective students, alumni, parents and the public. Information such as, admission criteria for prospective students, courses offered, news updates, fees etcetera are displayed on the websites [2]. All these users visit the University website for various purposes and they differ in terms of their frequency of use and competence with the use of technology [3]. Their expectations vary, therefore the University website should be designed to cater for these variations. For Universities to provide needed information and carry out their transactions there is the need for functional and usable website [4].

Usability is defined as "the extent to which a system, product, or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [5]. Usability is an important feature for a website to have [6]. If a website is found not usable or not meeting users' needs, they leave for other websites, those who manage to stay lead to frequent customer inquiries, support and subsequently lead to loss of revenue for website owners. Evaluating the usability of websites is helpful for locating problems with the interface design or its usage.

Usability of University websites has been studied by several researchers who have applied various methods to evaluate University website's usability. This gives information to the website developer on areas that need improvement. In this study, we carry out a systematic review of usability evaluation of University websites from the past 6 years, to gather information about trends, methods, and other information that are beneficial to University website developers, researchers and usability experts.

Several literature reviews have been conducted on website usability evaluation, not many have focused on University website usability evaluation. Literature reviews on University website evaluation have based their review on certain aspect of usability evaluation such as the methods used. [7] Performed a systematic literature review to find the trends in accessibility of University websites published in 42 papers. The result presented analysis of evaluation of 9140 Universities in 67 countries. The report presented important accessibility problems. A survey on research trends on University website usability was conducted by [4]. A total of 35 scholarly articles were reviewed. The review was based on usability evaluation methods, MCDM approaches and automated tools. The result revealed that the most common methods of usability evaluation are heuristics evaluation, user testing and automated tools. MCDM approaches are

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increasing but not as much as other methods. [8] In their study evaluated University website usability evaluation from scholarly articles from 2006 to 2016. 53 papers were investigated and the result showed that the generally adopted method are user testing and questionnaire, the most reported usability issues were navigation, UI design and information content quality. This study reviewed more recent studies from 2016 to 2020, in addition to the methods of usability evaluation on University website we highlight other aspects like metrics used, objectives of study etcetera. This is to provide adequate information for Universities web developers and usability researchers. The rest of the paper is structured as follows: section 2 presents the method applied, section 3 presents the analysis of the result and lastly section 4 the conclusion from the analysis is discussed.

2. METHOD

A systematic review involves a process to systematically search and locate relevant studies about a research question and systematic presentation of the finding of the result from the search [9]. In this study, a systematic review was adopted because it involves a comprehensive search to locate relevant literature about a given concept. It tends to be of higher quality, transparent, more comprehensive and less biased than other literature review approaches. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting standard was adopted in this study because it is most widely applicable across different research areas. PRISMA was developed by [10] and is made up of four stages namely: identification, screening, eligibility and inclusion as shown in Figure 1. To achieve the main purpose of this study which is to gather information about trends and methods that have been adopted in conducting usability evaluation of university websites, the following research questions were determined:

1. In which countries were these studies carried out?
2. What is the distribution of studies by year?
3. What are the objectives of carrying out the studies?
4. What are the usability metrics considered in the studies?
5. What are the methods of website usability evaluation adopted?
6. How and what type of data is collected?
7. What data analysis method was used?
8. What is the stage of evaluation?
9. Which web pages were selected for evaluation?
10. What type of problems were found?
11. What measures were taken considering Covid-19 pandemic?

The identification stage involved the process of identifying relevant literature from electronic databases. In acquiring the relevant information, Google Scholar and IEEE were accessed. Search parameters such as “Evaluation of Academic website”, “Usability of academic websites”, Usability of higher education websites”, “University website evaluation” were used to search for articles. This study focused on more recent articles published between 2016 and 2021. Usability evaluation for visually impaired, mobile interfaces were excluded because the focus of the study is mainly on websites, further study will focus on usability for visually impaired. The inclusion and exclusion criteria considered are highlighted in table 1. Titles that included usability, quality, accessibility, navigation were included because these are usability metrics that have to do with usability evaluation. After identification, 84 articles were selected. In the screening stage, the search result was screened, a quick scan of the abstract was done and articles that had potentials of relevance selected, duplicate articles were removed. In the eligibility stage, the full texts of the articles were studied, focusing on their relevance as regards the research questions formulated. At this stage, different metrics, elements and methods used by researchers were identified and these articles were chosen at the inclusion stage. At the end 32 articles were selected, 2 could not be downloaded.

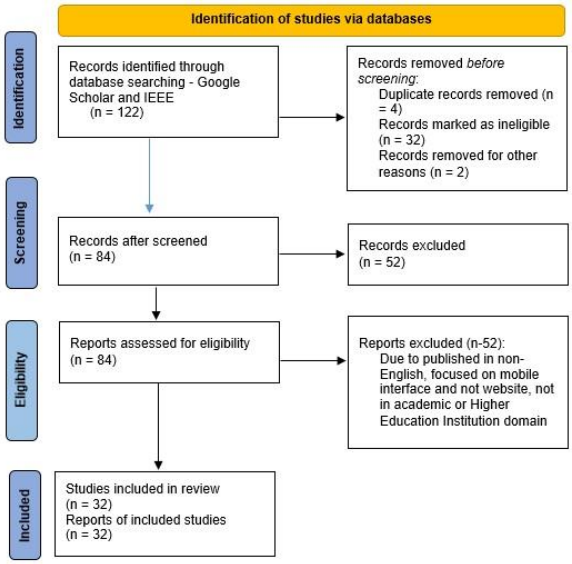

Figure 1 Data abstraction based on PRISMA flow diagram (Moher, 2013)

Table 1 Criterion for Screening

Criteria	Inclusion	Exclusion
Language	English	Non-English
Interface	Website	Mobile interface and others
Type of study	Usability and its elements	Not focused on usability
Publication date	2016 - 2021	Before 2016

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3. FINDINGS

In this section the findings of the systematic literature review based on answers to the research question are summarized, a total of 32 articles were selected and analyzed.

3.1 In which Countries were these Studies carried out?

In this study, 17 countries contributed to the review. The countries with the highest contribution are shown in figure 3.2 Jordan and Indonesia had the highest with 4 articles each, followed by Pakistan and Turkey with 3 articles each. However, in a comparative study carried out by [11], 348 Universities in Latin America were evaluated. This was not included in the countries in figure. 3.1

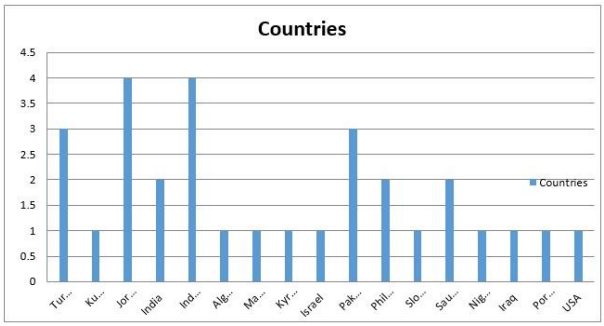

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Figure 3.1 Distribution of articles by country

3.2 What is the Distribution of the Studies by Year?

More recent researches were considered in this study, the articles considered are articles from 2016 to 2021. This is due to the fact that there is a similar study by [8] of articles from 2006 to 2016. The distribution of the studies by year can be seen in figure 3.2. The year with the highest number of articles is 2019 with 8 articles, 2020, 2018 and 2016 had the same number of articles each which is 6. 2021 had the least number of articles.

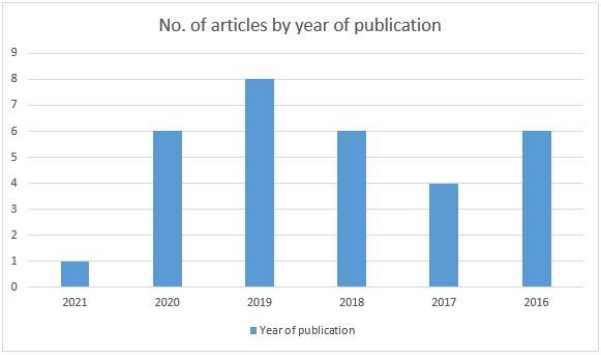

Figure 3.2 Distribution of articles by year

3.3 What are the Specific Objectives for carrying out the Studies?

In all the articles studied, researchers have specific objective for carrying out usability studies. These objectives were investigated and categorized into 7 as shown in Figure 3.3. 41% of the articles had the objective of evaluating the usability of the University website using different metrics and methods, 28% were interested in the accessibility of the University website, 16% were interested in determining the variables that affected users of the website, 6% investigated the navigability of the website and 3% were interested in assessing the performance, 3% proposed a model for University website evaluation, 3% compared the performance of automated tools on websites.

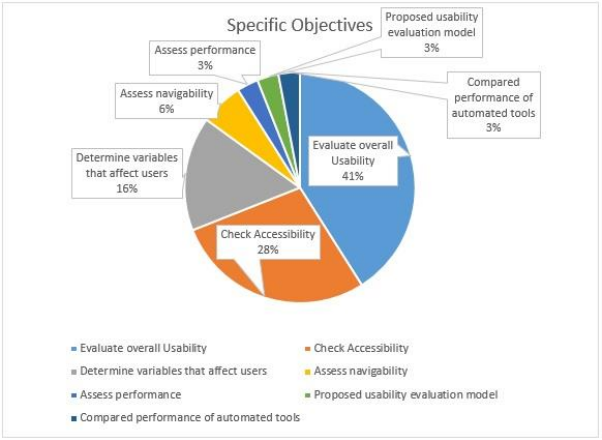

Figure3.3 Specific Objectives for University website evaluation

3.4 What are the Usability Metrics considered in the Studies?

Definition of metrics is an important aspect of any usability evaluation. This is what guides the data collection process. Several metrics were employed in the articles investigated; these metrics are measured by different criteria [12]. Some studies used standard usability metrics such as effectiveness and efficiency, while some studies devised metrics according to the intention of their study. Figure 3.4 shows the standard metrics employed, with accessibility being the most used, followed by usability. Other metrics such as load time, number of pages, interface design were also used.

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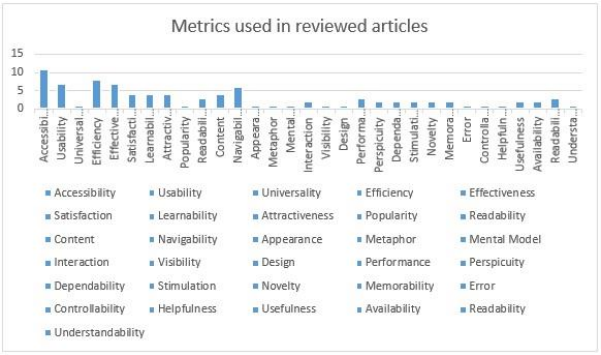

Figure 3.4 Metrics employed in studies

3.5 What are the Methods of Website Usability Evaluation adopted?

The methods of evaluation used in this study are basically classified into three: the inspection method, empirical method and tool based method. The inspection method involved usability experts checking the website interface to identify usability problems by checking it against standard usability checklist or guidelines usually referred to as heuristics [13]. The Empirical method involves real users accessing the website to identify usability problems with the website; usage data is collected with data collection methods such as questionnaires and there after analyzed. Some of the studies employed online tools and automated tools that check website usability against standard checklist and guidelines such as the Web Content Accessibility Guidelines (WCAG), Search Engine Optimization (SEO), and site security etcetera. As shown in Figure 3.5, 47% of the university website evaluation studies were conducted with automated tools 31% as empirical method, followed by 9.4% for inspection method. There were instances where the experts inspected website manually in conjunction with automated tool [14] or manual inspection with empirical method [15] and empirical method was used in conjunction with automated tool [16]. Frequent techniques used under empirical methods are questionnaires and survey, user interaction log was used by two studies [17] [18].

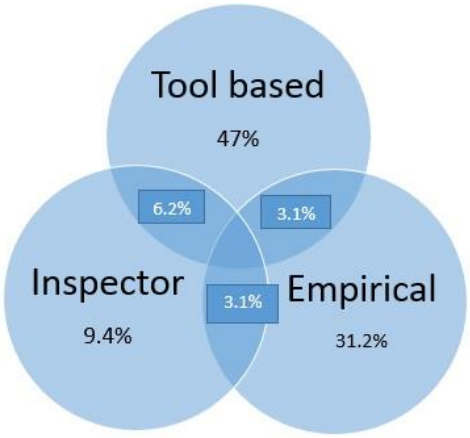

Figure 3.5 University website Usability evaluation methods

3.6 How and what type of Data was collected?

Mostly quantitative method was used for data collection, basically with questionnaires and survey, qualitative method such as interview, observation, think aloud and focus groups also adopted as show in Figure 3.6. Two studies collected website user interaction data by embedding JavaScript code into web pages of the website [17] [18]. Interaction such as mouse clicks, scrolls and cursor movement were captured and analyzed to identify usability problems.

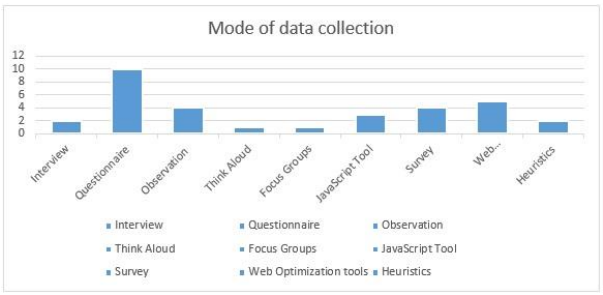

Figure 3.6 Mode of data collection

3.7 What Data Analysis Method was used?

The data analysis method used in the study was mostly descriptive analysis with 87.5% of the studies and predictive analysis was 12.5% as shown in Figure 3.7. The descriptive analysis results were reported using percentages, mean, median and mode. One study rendered user interaction in heat maps [18]. Some others applied predictive analysis such as Krug's test, linear programming, linear regression, AHP and correlation [19] [3] [20].

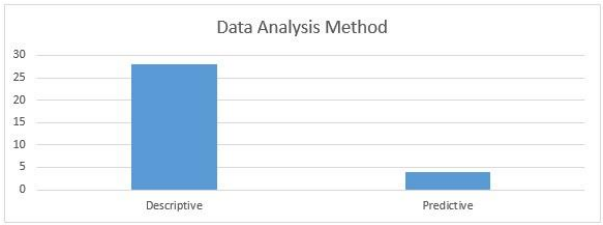

Figure3.7 Method of data analysis

3.8 What is the Stage of Evaluation?

All but one of the studies went through the formative form. Evaluation was done on University websites that were already existing and completed. One study carried out evaluation at the pre-production stage [18].

3.9 What Types of Web Pages were Evaluated?

The types of pages web pages that were evaluated in the studies were investigated. Not all the studies specified the web pages evaluated. The investigation shows that the homepage was evaluated more than other pages as shown in Figure 3.9.

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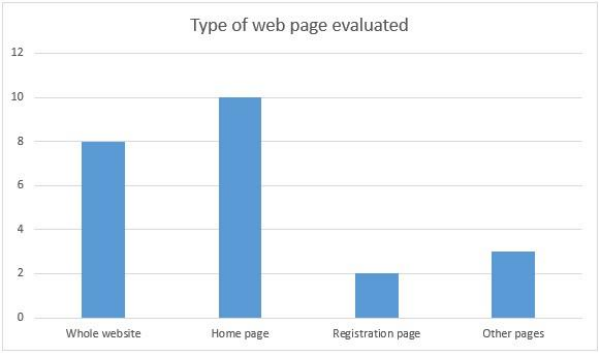

Figure 3.9 Types of web page evaluated

3.10 What are the Usability Problems Found?

The usability problems found in the studies reviewed are categorized into 5 as shown in Table 2. The most common usability issues are interface design related issues, navigation, content, performance and accessibility issues.

Table 2 Usability problems found

Usability Problems	
Interface design	• Missing Alternate text • Errors in code (e.g. html errors) • Design outdated • Empty labels • Not mobile friendly • Lack of icon description • Search box too small
Navigation	• Broken links • Page not found • Inappropriate labelling
Content	• Instant feedback missing • FAQ not available • Missing information • Search returning empty information
Performance	• Slow loading time • Lack of security due to outdated app
Accessibility	• Non-conformance to WCAG standards

3.11 What Measures were taken considering Covid-19 Pandemic?

The wake of covid-19 has caused a lot of adjustment to the way people interact. In this study measures taken into consideration because of covid-19 was investigated, only one study [21] mentioned the use of zoom meeting recordings and surveys to examine the participant information while using the website because of social distancing.

4. DISCUSSIONS

This study presents a systematic literature review on University website usability evaluation from studies done between 2016 and 2021 based on 32 research articles. It shows research trends between these periods. Several literature reviews have been done on website usability evaluation generally, but very few studies have focused on University website usability evaluation. Result of this study showed that apart from the general objective of evaluating the general usability of University websites, some researchers had specific objectives to evaluate the accessibility of websites, determine variables that affect users of websites, investigate navigability, assess performance, propose a model for University website evaluation and compare the performance of automated tools on websites. The most used usability metric was accessibility, 47% of the articles conducted evaluation with the tool based method, while 31.2% used empirical method. The most common method of data collection was questionnaire, 87.5% used descriptive analysis while 12.5% used predictive analysis. Only one study carried out evaluation at pre-production stage while all others at completion stage. Usability problems found were related to interface design, navigation, content, and performance and accessibility issues.

It was noted that many of the universities did not meet up to the standard of usability, usability evaluation should be included at the developmental stage, it was noted that usability is also taken as user experience by some researchers, [18] used UX attributes to measure usability. Some of the studies mentioned usability values not stating the problems found, stating the problems will help other researches. It was also noted that only university staff and faculty are employed as respondent, prospective students, parents could be respondent too to have a general overview from the aspect on non-university users.

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The Development of Textbook Based Mind Mapping

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Abstract: The purpose of this study was to determine the feasibility and effectiveness of Learning Planning textbook based mind mapping that was developed. This type of research is research and development with 4D model. The subjects of this research are material expert, media expert, and test subjects. The data collection techniques are validation sheets and tests. The feasibility result of material expert's assessment on the component aspect with a total percentage of 91.66% is included in very good criteria and feasibility assessment of material substance with a total percentage of 94.4% is in very good criteria while the result of validation based on media experts with total average score of 87 with very good criteria. The use of textbook based mind mapping in the Lesson Planning course is effective for improving college student learning outcomes with an average of 84.06 with very good criteria.

Keywords: Development, Learning Planning Textbook Based Mind Mapping, Feasibility, Effectiveness

1. INTRODUCTION

State University of Medan is one of the higher education institutions in Indonesia that has the responsibility to produce competitive graduates in the form of quality teachers. The Faculty of Economics as an integral part of Medan plays a role in the success of Medan's mission to answer challenges, opportunities, community demands, and prepare professional and competitive teacher candidates.

This quality graduate profile can be achieved by improving college students' creative thinking skills which are also part of life skills. The ability to think is an important competency that must be possessed by college students and is directed towards educational goals that are broadly based, useful, tangible, meaningful in preparing college students to face future challenges, especially preparation for the industrial revolution 4.0. The quality of learning is measured through mastery of learning, namely from the results and the learning process carried out.

Based on the results of observation made in the Lesson Planning course about the cause of the low mastery of college students in understanding the Lesson Planning course material, it is suspected that there is a lack of literature or references related to Learning Planning material. College students are only guided by textbook that have been used by lecturers without any other learning resources. In addition, college students are less skilled in finding new ideas to solve a problem, college students are also less enthusiastic about asking questions or answers to the problems discussed, less creative and lack of variety in conveying the results of activities.

The results of this observation were further confirmed when discussing with the lecturers of the Lesson Planning course. The results of the discussion show that college students have not been able to think creatively when solving a problem with a different point of view and college students tend to be passive in learning so they cannot explore their creative ideas. The low creative thinking ability of college students certainly has direct implications for the mastery of the Lesson Planning course. The lesson planning course is not fully and thoroughly mastered by college students. This can be seen from the final score of college students in the semester last year.

Optimization efforts need to be done, namely developing learning media, especially the development of textbooks that can improve college students' creative thinking skills. The textbook that has been used so far cannot explore college students' creative thinking skills and mastery of Learning Planning courses. The development of Learning Planning textbook based mind mapping needs to be held to improve college students' creative thinking skills and mastery of Learning Planning materials. Jensen and Makowitz argue that mind mapping is a way of visualizing verbally into visuals or images which can make it easier to store, strengthen, and recall information that has been learned [1]. Furthermore, Edward explains mind mapping is a very effective and

efficient method to store and retrieve data or information from or to the brain. This system works according to the natural workings of the human brain, so that the potential and capacity of the human brain can be optimal [2]. Then, Zampetakis and Tsironis stated that mind mapping is a way that can make a boring task fun and interesting, so that it can optimize concentration and memory. With mind mapping, the student's ability to be active and remember will increase [3]. Meanwhile, Windura explained simply that Mind map is a graphic technique that allows a person to explore all the abilities of the brain for the purposes of thinking and learning [4]. Mind maps are designed to map all knowledge completely and thoroughly. Mind maps are one of the easiest ways to put information into the brain and take information out of the brain. In addition, mind maps can also develop the work potential of the two hemispheres of the brain both in writing and verbally by using a combination of colors, symbols, shapes and so on so that the brain can easily absorb the information received. The use of this Learning Planning textbook will help college students activate their whole brain, look for a chronological order of a problem, focus their thoughts on a theme and provide a clear picture of a lecture material so that they can improve their creative thinking skills and achieve mastery of Learning Planning courses.

Based on the background of the problems described above, the problem that becomes the study material in this research are how is the feasibility textbook based mind mapping developed in the Lesson Planning course in the Department of Economics Education, Faculty of Economics, State University of Medan? and how is the effectiveness textbook based mind mapping developed in the Lesson Planning course in the Department of Economics Education, Faculty of Economics, State University of Medan? The purposes of this study ware to determine the feasibility and effectiveness of the textbook based mind mapping developed in the Lesson Planning course in the Department of Economics Education, Faculty of Economics, State University of Medan.

2. METHOD

This study is a research and development type. Putra defines research and development as a research method that is intentionally, systematic, aimed/ directed to find, formulate, improve, develop, produce, test the effectiveness of products, models, methods/ strategies/ methods, services, certain procedures that are superior, new, effective, efficient, productive and meaningful [6]. The product produced in this study is a textbook based mind mapping in the Lesson Planning course in the Economic Education study program, Faculty of Economics, State University of Medan.

This study uses 4D model. Thiagarajan in Sugiyono said that the development of 4D model consists of 4 main stages, namely: 1) define, 2) design, 3) develop, and 4) disseminate [7]. This research was only carried out until the develop stage, the disseminate stage was not carried out due to cost and time constraints.

This study uses validation sheets and tests as instruments of collecting data. Validation sheets are used to obtain data about feasibility of the developed product and tests are used to obtain data about effectiveness of the developed product. The research data were analyzed to determine feasibility and effectiveness of the developed product. The feasibility of the developed product can be seen from the assessments of material expert and media expert. The effectiveness of the developed product can be seen from the pretest and posttest answered by the third semester B class 2019 college students in the Economic Education study program, Faculty of Economics, State University of Medan.

3. RESULTS

3.1 Define Stage

The define stage is carried out by conducting curriculum analysis, concept analysis, college student analysis and needs analysis. The steps of this define stage are as follows:

Curriculum analysis

Curriculum analysis is done by analyzing Competency Standard and Basic Competencies in the Lesson Planning course. The results of the analysis of Competency Standard and Basic Competencies become the formulation of learning indicators. The formulation of the learning indicators are as follows:

1. Understand the nature of learning planning,
2. Understand the learning system design model oriented to the achievement of goals,
3. Understand the planning of learning programs,
4. Understand competency development as a learning objective,
5. Understand learning strategies,
6. Design learning activities,
7. Understand the development of learning resources and learning media,
8. Understand the technique of preparing and implementing the evaluation of learning outcomes.

The learning indicators that have been developed are formulated as the basis for learning objectives. The learning objectives that must be mastered by college students in the learning process are set as follows:

1. College students are expected to be able to understand the nature of learning planning including definition, importance, benefits, functions, criteria and steps for making learning planning,
2. College students are able to understand the learning system design model oriented to the achievement of goals including: definition of curriculum based competency, characteristics of curriculum based competency, expected competencies in learning, syllabus development and implementation, and competency achievement instructional system design model,
3. College students are expected to be able to plan learning programs including: the nature of learning planning, development of learning programs, syllabus, annual program planning, and semester program planning,

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4. College students are able to develop the competence of learning objectives including: the nature of learning objectives, the hierarchy of educational and learning objectives, classification of learning objectives, and the format of designing learning objectives,
5. College students are able to develop learning strategies including: definition of learning strategies, approaches, strategies, methods, techniques and learning models, principles of using learning strategies, and learning organizing strategies,
6. College students are expected to be able to design learning activities including: the need for preparation of lesson plan, definition and function of lesson plan, and components of lesson plan,
7. College students are able to develop learning resources and media including: utilization of learning resources, choosing learning resources, learning media, benefits and functions of learning media, use of learning media, classification and types of learning media, characteristics of learning media, and selection and use of learning media,
8. College students are able to design techniques for the preparation and implementation of the evaluation of learning outcomes including: steps for preparing the evaluation of learning outcomes, planning for the preparation of evaluation of learning outcomes, writing items for evaluating learning outcomes, strengths and weaknesses of essay test, use of essay test, classification of essay test, and implementation techniques evaluation of learning outcomes.

Concept analysis
Concept analysis aims as the basis for the main concepts that must be mastered by college students in the learning process. In the concept analysis, the identification and formulation of the main concepts will be compiled in the material in the textbook based mind mapping. Based on the learning indicators and learning objectives, the main concepts are determined as follows:
1. Definition, importance, benefits, functions, criteria and steps for making learning planning,
2. Definition of curriculum based competency, characteristics of curriculum based competency, expected competencies in learning, syllabus development and implementation, and competency achievement instructional system design model,
3. The nature of learning planning, development of learning programs, syllabus, annual program planning, and semester program planning,
4. The nature of learning objectives, the hierarchy of educational and learning objectives, classification of learning objectives, and the format of designing learning objectives,
5. Definition of learning strategies, approaches, strategies, methods, techniques and learning models, principles of using learning strategies, and learning organizing strategies,
6. The importance of preparing lesson plan, understanding and function of lesson plan, as well as the components of lesson plan,
7. Utilization of learning resources, choosing learning resources, learning media, benefits and functions of learning media, use of learning media, classification and types of learning media, characteristics of learning media, and selection and use of learning media,
8. Steps for preparing the evaluation of learning outcomes, planning for the preparation of evaluation of learning outcomes, writing items for evaluating learning outcomes, strengths and weaknesses of essay test, use of essay test, classification of essay test, and implementation techniques evaluation of learning outcomes.

College students analysis
College students analysis was conducted to determine the characteristics of college students. Characteristics of college students include age, motivation, background knowledge of college students, academic abilities, and social skills. Furthermore, psychological changes that occur such as efforts to find identity, future aspirations begin to arise, freedom to do something. Some college students have started to be able to think abstractly and be scientific. Thus, they are able to understand abstract meaning and principles based on formal concepts and theories, and can formulate hypotheses and think systematically in dealing with a problem.

Needs analysis
The needs analysis was carried out by distributing questionnaires to the third semester 2019 college students in the Economic Education study program, Faculty of Economics, State University of Medan as many as 30 persons by describing the definition of textbook based mind mapping firstly in the questionnaire in order to have an overview of the questions in the questionnaire submitted. The summary of the needs analysis data can be seen in the following table.

Table 1. The Summary of Needs Analysis Data

No.	Statement	Answer	Frequency	Percentage
1	Know Learning Planning textbook based mind mapping	Yes	2	6,66 %
		No	28	93,33 %
2	Use Learning Planning textbook based mind mapping	Yes	0	0 %
		No	30	100 %
3	Need Learning Planning textbook based mind mapping	Yes	30	100 %
		No	0	0 %

Based on the table, it can be concluded that the development of textbook based mind mapping is needed by college students in the learning process for the Lesson Planning course.

3.2 Design Stage

At this stage, the researcher designed and compiled a textbook based mind mapping. The draft product specifications are as follows:
Formulation of Learning Objectives
The formulation of learning objectives is arranged specifically and systematically based on curriculum provisions. The formulation of learning objectives starts from setting

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competency standard, basic competencies and indicators of achieving learning objectives. From the indicators formulated learning objectives that must be mastered by college students. The learning objectives of the cognitive and psychomotor domains are formulated based on competency standard, basic competencies and indicators that have been determined by the curriculum.

Description of the Contents of Textbook

The description of the material or content of teaching materials refers to the Indonesian National Qualifications Framework (KKNI). The curriculum which initially refers to the achievement of competencies becomes referring to learning outcomes.

3.3 Develop Stage

The development phase includes expert validation and testing of textbook based mind mapping to see the feasibility and effectiveness.

Feasibility of the developed product

The textbook that has been compiled were validated by 2 (two) validators, namely 1 expert in the field of Learning Planning and 1 learning design expert. Material expert validation is intended to obtain information on the quality of textbook based mind mapping that has been developed, while media expert validation is carried out to improve the quality of the developed textbook. The results of the assessments from material and media expert can be seen in the following table.

Table 2. Material Expert's Assessment on Component Aspect

Assessment aspect	Assessment indicators	Score
Component	1. Interesting title and in accordance with the content	4
	2. Contains core competencies and basic competencies	4
	3. Compatibility between indicators and basic competencies	3
	4. Learning objectives are in accordance with core competencies and basic competencies	3
	5. Demonstrate the benefits gained by the learners	4
	6. In accordance with the learning objectives	4
	7. There is perception and material enrichment	4
	8. There are examples of questions that are in accordance with the learning objectives	4
	9. Stimulate college students to develop knowledge	4
	10. There are exercises / tests / stimuli that are in accordance with the learning objectives that allow college students to master the expected basic competencies	3
	11. There is a list of actual references from books, print/electronic media, and scientific journals	3
	12. Compliance with reference writing rules	4
Total Score		44
Percentage		91.66 %
Criteria		Very Good

Based on the table, it can be seen that the result of the material expert's assessment on the component aspect of textbook based mind mapping developed were declared very good with percentage of 91.66 %.

Table 3. Media Expert's Assessment on Material Substance Aspect

Assessment aspect	Assessment indicators	Score
Material Substance	1. In accordance with scientific principles	4
	2. Tested	4
	3. Factual (based on facts)	4
	4. Logical/ rational	3
	5. Completeness of materials	3
	6. Exploration/ development	4
	7. Collaboration with other materials/ other subjects	4
	8. Descriptive/ imaginative	3
	9. Actualization (in terms of material)	4
	10. Innovative (bringing up new things)	4
	11. Standard language and can be understood	4
Total Score		41
Percentage		94.54 %
Criteria		Very Good

Based on the table, it can be seen that the result of the material expert's assessment on the material substance aspect of textbook based mind mapping developed were declared very good with percentage of 94.54 %.

Table 4. Media Expert's Assessment

Components	Indicators	Average Score	Criteria
A. Textbook	1. Textbook size conformity with	4	Very

Size	ISO standards (A4, A5, and B5)		Good
	2. Size suitability with the content of the textbook	4	Very Good
B. Textbook Design (Cover)	3. The appearance of the layout elements on the front, back and back covers harmoniously has rhythm and unity and is consistent.	3	Good
	4. Shows a good center of view.	3	Good
	5. The color of the elements of the layout are harmonious and clarify the function	3	Good
	6. The composition and size of the layout elements (title, author, illustration, logo, etc.) are proportional, balanced, and in rhythm with the layout of the content (according to the pattern)	3	Good
	Typography cover		
	7. The font size for the title of the textbook is more dominant and proportional than the size of the textbook, the name of the author.	3	Good
	8. The color of the textbook title contrasts with the background color	4	Very Good
	9. Don't use too many typeface combinations		
	Illustration of a textbook cover		
	10. Describe the content/teaching materials and reveal the character of the object		Good
	11. Shape, color, size, proportion of the object according to reality	4	Very Good
C. Textbook Content Design	Layout Consistency		
	12. Consistent placement of layout elements based on patterns	3	Good
	13. The separation between paragraphs is clear	3	Good
	Harmonic Layout Elements		
	14. Print area and proportional margins	4	Very Good
	15. The margins of two pages side by side are proportional	3	Good
	16. Spacing between text and illustration is appropriate	3	Good
	17. Chapter titles, subtitles, illustrations, and picture captions do not interfere with understanding	4	Very Good
	Typography		
	18. Do not use too many typefaces.	4	Very Good
	19. The use of letter variations (bold, italic, all capital, small capital) is not excessive	4	Very Good
	20. The typeface is in accordance with the content material	4	Very Good
	21. The layout of the text is between	3	Good

	45-75 characters		
	Illustration of Contents		
	22. Able to reveal the meaning of the object	3	Good
	23. Accurate and proportional shape in accordance with reality	4	Very Good
	24. Presentation of the whole illustration	3	Good
	25. Creative and dynamic	3	Good
Total average score		87	Very Good

Based on the table, it can be seen that the result of the media expert's assessment on the textbook size, textbook design (cover) and textbook content design aspect of textbook based mind mapping developed were declared very good with total average score of 87.

Effectiveness of the developed product

The effectiveness of textbook based mind mapping was tested on class B college students in the third semester of Class 2019 Economic Education Study Program, Faculty of Economics, State University of Medan using tests. The tests carried out are classified into 2 types of tests, namely pretest and posttest. The results of the data recapitulation obtained from the pretest and posttest are described in the following table.

Table 5. Pretest and Posttest Results

No	Pretest	Posttest
1	60	85
2	60	80
3	45	85
4	60	90
5	55	95
6	60	90
7	55	85
8	50	80
9	65	85
10	50	75
11	65	90
12	55	85
13	55	80
14	50	75
15	60	80
16	65	80
17	60	85
18	55	75
19	70	95
20	55	85
21	60	95
22	50	80
23	55	75
24	55	95
25	65	80
26	60	80
27	65	95
28	55	90
29	65	90
30	60	75
31	50	80
32	60	75
Total	1850	2690
Average	57.81	84.06

The table shows that the pretest of college students obtained a total of 1850 with an average of 57.81 being in the deficient criteria, while the posttest or in other words the test carried out after the application of textbook based mind mapping obtained a total of 2690 with an average 84.06 on the very good criteria. Based on the table, it can be concluded that the average score obtained by college students has increased where after using textbook based mind mapping, it was 84.06 compared to 57.81 before using textbook based mind mapping.

4. CONCLUSIONS

Based on the feasibility result of material expert's assessment of component aspect that was developed, it was declared "very good" with a total average percentage of 91.66%. and material expert's assessment on material substance aspect is considered "very good" with a total average percentage of 94.54%. While the result of media expert's assessment concluded that the learning media developed were in the "very good" criteria with a total average score of 87. In terms of effectiveness, the use of textbook based mind mapping is effective for improving college student learning outcomes with a total score of 2,690 with an average of 84.06 which is included in the "very good" criteria.

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