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Classification of Metacognitive into Two Catagories to Support the Learning Process

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Abstract: Learning outcomes are the patterns of actions, values, understanding, attitudes, appreciation and skills. Learning outcomes are related to the metacognitive of student where the elements contained in metacognitive is cognitive. The relationship between cognitive and metacognitive which is the foundation of cognitive is metacognitive. There are two components such as knowledge of metacognitive and regulation of metacognitive. In the learning process, cognitive factors are not the only one that can support, but also a metacognitive factor is a very influential factor for the success of the learning process. Thus, it is very important to do with a deeper analysis about metacognitive by identifying metacognitive level to support the learning process. Identification of metacognitive is performed by using Naïve Bayes Classifier algorithm (NBC) which NBC is one of an algorithm that is used for classification algorithm for data mining. In these studies, it is obtained that the accuracy scored 88,0597% when tested using NBC.

Key Words: metacognitive, knowledge of metacognitive, regulation of metacognitive, cognitive, Naïve Bayes Classifier (NBC)

Abstrak: Hasil pembelajaran merupakan pola tindakan, nilai-nilai, pemahaman, sikap, apresiasi dan keterampilan. hasil belajar terkait dengan metakognitif siswa di mana unsur-unsur yang terkandung dalam metakognitif adalah kognitif. Hubungan antara kognitif dan metakognitif merupakan dasar dari kognitif adalah metakognitif. Terdapat dua komponen dalam pengetahuan metakognitif dan regulasi metakognitif. Dalam proses pembelajaran, faktor kognitif bukan satu-satunya yang dapat mendukung, tetapi juga faktor metakognitif adalah faktor yang sangat berpengaruh bagi keberhasilan proses pembelajaran. Jadi, sangat penting untuk melakukan analisis yang lebih mendalam tentang metakognitif dengan mengidentifikasi tingkat metakognitif untuk mendukung proses pembelajaran. Identifikasi metakognitif dilakukan dengan menggunakan algoritma Naïve Bayes Classifier (NBC) dimana NBC merupakan salah satu algoritma yang digunakan untuk algoritma klasifikasi untuk data mining. Dalam penelitian tersebut diperoleh bahwa nilai akurasi adalah 88,0597% saat diuji menggunakan NBC.

Kata kunci: Metakognitif, Pengetahuan Metakognitif, Peraturan Metakognitif, Kognitif, Naïve Bayes Classifier (NBC)

Cognitive development is a determinant of learners intellectual intelligence which is the cognitive ability will continue to evolve with physical factors and brain as the main of it. In addition, the development of cognitive followed with how to organize or manage the ability to solve a problem. In this case, cognitive of someone is unable to walk solitary but they need to be controlled and set up so if someone is going to use their own cognitive, they need the ability to organize the cognitive. Learning outcomes are related with metacognitive of student where the elements contained in metacognitive is cognitive. Relation between metacognitive and cognitive is metacognitive means a foundation of cognitive. The successive of learning outcomes of students is determined by cognitive and metacognitive factors as a support and foundation for cognitive learners. Someone must have awareness about their mind and be able to manage and controlled it. In this case the meaning of ability mentioned before is called as

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metacognitive. Metacognitive ability sometimes represented by aiming their own selves. As a simply, metacognitive defined as "thinking about thinking" (Elawar, 1995). Basically, metacognitive is an awareness of thinking about what is known and what is unknown. In the learning context, learner know how to learn, knowing their capabilities and learning modality and determine the best learning strategies for effective learning.

Metacognition is an object of cognition which is classified from learner experience and information transform to perform monitoring and metacognition control, learners are actively involved in how to learn and factors that guarantee their learning process (Winne, . In the learning process, there is a learning evaluation, in this case, role of metacognitive is very influential for them so learners can cultivate the ability of self-learning evaluation learning that has been passed which in principle is considered as an important component of self-learning (McCabe, 2011).

This study focuses on extracting the aspects that exist in metacognitive and gain the learners' knowledge that will be used in identifying metacognitive level. There are two main components in metacognitive that is knowledge of metacognitive and regulation of metacognitive (Sware, 1994). Knowledge of metacognitive is an indicator of how well for someone to use the method and strategies to control and enhance learning and knowledge (McCabe, 2011; Nett, et al, 2012; Kelemen, et al, 2000). Here is a map of research shown in Figure 1.

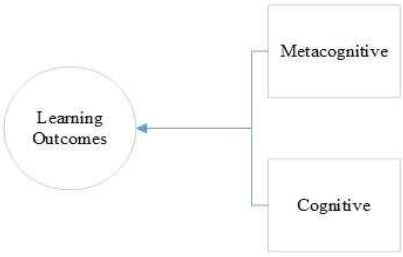

Figure 1. Research Scheme

Previous research about image classifier to classify the mammogram images by classify into malignant, benign and normal cases. Correlation based feature selection (CFS) to reduce 50% of features. Correlation based feature selection (CFS) has a function to remove the uncorrelated features and select the significant feature from the original features (Choridah, 2014).

As a simply, metacognitive defined as "thinking about thinking" (Coskun, 2010). Metacognition is a reflection of the mind, thought to their own mind. Nett, et al stated that metacognitive strategy is a strategy that involves cognitive learning and motivation, metacognitive can be interpreted as a theoretical model which has an important role in the success of independent learning (Sharabiani, 2014; Kelemen, 2000; Durall, 2012; Biswas, 2014). Basically, Metacogntive is the awareness of what is known and what is unknown. In the context of learning, students know how to learn, determine the ability of learning, learning of the owned modality and determine the best learning strategies for effective learning. Flavel defined metacognitive as one's knowledge with respect to the cognitive process and product by itself or everything which is related to the process and the product (John, 2006). Metacognitive is a knowledge about the regulation of cognitive activity of individuals in the learning process (Veenmann, 2006). Corebima states that metacognition is related to think how to think, knowing what we know, and we do not know, learn how to learn, develop thought process on an ongoing basis so it can be used to solving the problem (Corebima, 1994). Schraw devide metacognitive into two main components i.e *metacognitive knowledge* and *metacognitive control*. All components can be seen in Table 1.

As stated in the National Education System Regulation. Education is a conscious and deliberate effort to create an atmosphere of learning and the learning process so learners are actively developing their potential to have spiritual power of religion, self-control, personality, intelligence, noble character and skills which are needed for them, society for the nation and state. In a real practice, there is a gap between reality and the aim of education in which the results of empirical observations indicate that most learner's failures in learning process not due to cognitive factors but metacognitive factors, because basically students who entered on a favorite school have a background in an excellent cognitive, however there are some failures in learning, so the evaluation to identify the metacognitive level is one of solution to improving the quality of education.

METHOD

In recent years, an analysis of student's metacognition is very important and a lot of research topics being work on by some researches (Kelemen,

Table 1. Componets of Metacognitive

Component	Indicator	Description
Knowledge of metacognitive	Declarative knowledge	Knowledge of the skills, resources and capabilities of a person as a learner
	Procedural knowledge	Knowledge of how to implement learning steps
	Conditional knowledge	Knowledge of why and when learning steps used
Regulation of metacognitive	Planning	Plan learning process, setting the goals, allocating the resources for learning priorities.
	Information management	Skills and strategy to efficiently process information (such as organizing, elaboration, summarizing, focusing election)
	Monitoring	Assessment of learning or use of strategies
	Debugging	The use of strategies to improve/check for errors in the understanding and implementation/achievement
	Evaluation	Analyzing the achievements and effectiveness of the strategy after learning process

2000; Xu, 2009; McCabe, 2011. Previous research using cognitive and metacognitive to analyze student learning behaviors (Biswas, 2011), metacognitive interaction is monitored according to learning process (Schwartz and Chase, 2009) strategy is used to analyze an Open Ended-Learning Environments (Biswas, 2000).

This research was done in 8 stages, shown in figure 2. The first stage is the study of the theory which is used to compose a research instrument that will be used for data retrieval. Schraw and Dennison makes absolutely an instrument to measure the components of metacognition called Metacognitive Awareness Inventory (Inventory of Metacognition) (Sware, 1994). That inventory contains knowledge of metacognitive and control metacognitive factors. There are 17 questions related to knowledge factor metacognition and there are 35 questions related to factor settings or metacognition control.

The research began with collecting the data using MAI. Then 52 items of MAI selected using feature selection. Feature selection is a process of selecting appropriate subset of original featured. Optimization of feature selection from the subset is a measure of evaluation criteria (Liu, 2012). On this research of 52 items which is divides into 8 indicators on each indicator will be grouped into two main components. Sub attribute of 8 indicators are shown in Table 1, included *Declarative Knowledge* (ZDK), *Procedural Knowledge* (ZPK), *Conditional Knowledge* (ZCK), *Planning* (ZPN), *Information Management Strategies* (ZIMS), *Comprehension Monitoring* (ZCM), *Debugging Strategies* (ZDS) and *Evaluation* (ZEV).

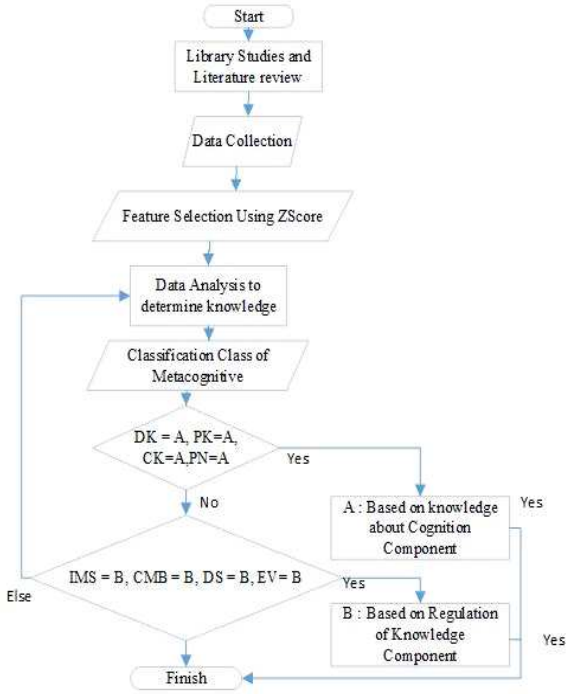

Figure 2. Research Methodology

This research uses a z-score analysis to compare one attribute with another attribute and will be classified into two components. Z-score also known as zero-mean, where the value of attribute of A normalized based on average value and standard deviation of attribute of A. A value v of A has normalized

$$v' = \frac{v - \bar{A}}{\sigma_A} \quad (1)$$

attribute become v' where $\overline{A}$ and σ_A are mean and standard deviation (Junaedi, et al, 20111). The equation z-score can be seen in equation 1.

A NBC (Naïve Bayes Classifier) algorithm used to classify the scored results from z-score process. Naïve bayes classifier is classification model which has several advantages, including: 1) easy to learn and understand, 2) more efficient, 3) have high accuracy (Mark & Sucar, 2006). NBC is a method of probability and statistics stated by the UK scientist Thomas Bayes. Bayes theorem can predict future probability based on previous experience. This theorem compared with the Naïve which is assumed that every attribute is independent (Mark & Sucar, 2006). Here are the equation from theorem naïve bayes as shown by equation (2) and (3).

$$\text{posterior} = \frac{\text{likelihood x prior}}{\text{evidence}} \quad (2)$$

$$p(y|x) = \frac{p(x,y)}{p(x)} = \frac{p(x|y)p(y)}{\sum_{y=1}^{C} p(x|y')\,p(y')} \quad (3)$$

NBC algorithm is commonly used for classification data set by using a generative function. The classification process requires a number of dues to determine best suited class for analyzed samples. In addition, NBC concept can be used to correlate the hypothesis too. Correlation of hypothesis is shown

$$P(Y|X) = \frac{P(Y)\prod_{i=1}^{q} P(X_i|Y)}{P(X)} \quad (4)$$

on the label of a mapping class that will be used in the classification. The input vector that contain the features in the concept of NBC is X and class label is Y, so Naïve Bayes can be written by $P(Y|X)$. The notation on Naïve Bayes showed by *posterior probability* which represented by Y and *prior probability* which represented by X. Therefore, Bayes theorem can be seen in equation (4) (Bustami, 2014).

Learning outcomes is not only affected by cognitive factor but there is metacognition factors that supporting the learning process. Analyzing this research done by classify knowledge of metacognitive and regulation of metacognitive (Sware, 1994).

This research observed first grade of computer network engineering in SMKN 2 Singosari, Malang as a population and use two classes of it as a sample. The metacognitive questionnaires were distributed to 67 students. The goal of this research is to shown the dominant component between knowledge of metacognitive or regulation of metacognitive by using combination of NBC and z-score analysis.

RESULTS AND DISCUSSION

The result of feature selection will be scoring values for each attribute in each z-score. Results of feature selection using z-score are shown in table 2.

Scoring is done by sorting based on highest value at each scoring of respondents where the sample is shown in table 3. In table 3 are shown 10 sample of data from 67 data. Z-score has a function to balance between two main components, because in one

Table 2. Feature Selection Using ZScore

ZDK	ZPK	ZCK	ZPN	ZIMS	ZCM	ZDS	ZEV
0.304	-0.363	-0.041	0.234	0.050	-0.398	15.152	10.718
-0.787	-0.363	-0.846	-10.176	-0.278	-11.428	-0.384	-0.278
-0.132	-1.046	-0.846	0.025	-0.442	-0.398	0.566	-0.548
-0.569	-0.704	-0.577	-10.176	-0.771	-0.398	-0.700	-0.548
-0.569	-0.363	-0.041	-0.600	0.706	-0.647	-0.067	-0.278
-0.351	-13.880	-0.309	-0.392	-0.114	-0.895	-0.700	-0.278
-16.136	0.321	-0.228	21.111	20.184	-18.344	-0.566	-2.152
-18.782	-0.704	-21.878	-0.600	-0.771	-11.428	-16.495	-21.682
0.304	0.663	-0.309	0.442	0.706	-0.647	-13.330	-0.008
-0.787	-0.021	-16.510	-1.435	-1.591	-0.398	-16.495	-1.088

Table 3. Sample of Scoring Attribute

ZDK	ZPK	ZCK	ZPN	ZIMS	ZCM	ZDS	ZEV	CLASS
6	2	1	5	4	3	8	7	RK
4	6	3	2	7	1	5	8	KC
6	1	2	7	4	5	8	3	RK
6	3	5	1	2	8	4	7	KC
3	4	7	2	2	1	6	5	RK
5	1	6	4	8	2	3	7	RK
5	2	1	8	7	6	3	4	KC
2	7	8	5	6	4	3	1	RK
5	7	3	6	8	2	1	4	RK
6	8	1	4	3	7	2	5	KC

Table 4. Classification By Using Naïve Bayes Classifier

Correctly Classified Instances	58	88.0597%
Incorrectly Classified Instances	8	11.9403%
Kappa statistic	0.7599	
Mean absolute error	0.146	
Root mean squared error	0.2688	
Relative absolute error	29.3327%	
Root relative squared error	53.861%	
Total Number of Instances	67%	

Attribute	**Class**	
	RK	**KC**
	(0,54)	(0,46)
ZDK		
Mean	4.3333	5.0645
Std.dev	2.3214	2.0468
Weight sum	36	31
Precision	1	1
ZPK		
Mean	4.7222	4.5484
Std.dev	2.1809	2.2409
Weight sum	36	31
Precision	1	1
ZCK		
Mean	4.7778	4.1935
Std.dev	2.0831	2.0386
Weight sum	36	31
Precision	1	1
ZPN		
Mean	4.4444	4.2581
Std.dev	2.1402	2.1845
Weight sum	36	31
Precision	1	1
ZIMS		
Mean	3.7778	4.9355
Std.dev	2.225	2.5645
Weight sum	36	31
Precision	1	1
ZCM		
Mean	3.9722	4.6129
Std.dev	2.2421	2.4053
Weight sum	36	31
Precision	1	1
ZDS		
Mean	6.4722	2.6452
Std.dev	1.6242	1.8413
Weight sum	36	31
Precision	1	1
ZEV		
Mean	3.3333	5.7419
Std.dev	1.9861	1.5651
Weight sum	36	31
Precision	1	1

component has 3 indicators such as in knowledge metacognitive there are declarative knowledge (DK), procedural knowledge (PK) and conditional knowledge (CK). And for regulation of metacognitive, there are 5 indicator such as planning (PN), information management (IMS), Monitoring (CM), Debugging (DS) and Evaluation (EV). Analyzing using zscore can make it easy to analyze the diffirent sum of each attribute.

Based on result from analysis using Naive Bayes Classifier, obtained an accuracy 88.0597% with correctly classified instances is 58. While incorrectly classified instance is 8 with 11.9403% errors.

CONCLUSIONS

Classification of metacognition is done by using feature selection and using z-score approach to give scoring in each attribute because scoring indicators on each component is different. Then, to balance the assessment with the sum of different indicators can prove the solution for data that has a number of different attribute. In these studies obtained accuracy 88,0597% when tested using NBC.

The results of this research is knowledge of cognition has percentage is 50% and the percentage

of knowledge of regulation is 48%. So in this case, most of the students have knowledge of cognition more dominant than regulation of knowledge.

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