

CORRELATION BETWEEN COMPETENCE MASTERY LEVEL IN CRITICAL THINKING AND STUDENT GRADUATION ACCURACY

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Abstract

This study aims to analyze the relationship between competence mastery level in critical thinking as one of factors determining graduation accuracy of students in Teacher Training and Education Faculty, University of Islam Malang. Critical thinking is a meaningful process to direct oneself in making a decision. This study uses a quantitative method and the data applied here is Tracer Study data of FKIP UNISMA from 2017 to 2020. Student graduation accuracy data is nominal with two categories and the data of competence mastery level in critical thinking is ordinal with five categories. Data analysis uses CHAID (*Chi-square Automatic Interaction Detector*) which is implemented in IBM SPSS 25. The results show that there is a significant relationship between competence mastery level in critical thinking and student graduation accuracy.

Keywords: Critical thinking, student graduation accuracy, CHAID, tracer study

The era development demands improvements in the quality of Indonesian education in order to produce human resources that have high competences. Education is very useful in enlightening the nation life and improving the nation quality as a whole. This is affirmed in Law No. 20 of 2003 on the National Education System which confirms that education is a conscious and planned effort to manifest a learning atmosphere and learning process so that learners actively develop their potential to have religious spiritual strength, self-control, personality, noble moral intelligence, as well as skills needed by themselves, society, nation and state. University is one of institution organizing this education which also plays a very important role in developing the competitiveness of the nation by improving the quality of human resources and through its real role in producing educated workforces, developing science, etc. (Wulandari, et al, 2011). University, as one of the educational institutions, has a duty to be able to produce professional human resources which have high competitiveness. (Haryati, 2015).

One of University's steps in maintaining its performance is by continuously trying to improve its learning quality. A quality-oriented learning should not only focus on improving student hard skills but also on their soft skills. This is in line with the results of a study conducted by the Indonesian Ministry of Education in 2009, which showed that 85% of a person's success in education is determined by soft skills that he is mastered (Muhmin, 2018). Sulistio (in Wulandari, et al, 2011) says that competency standards are a combination of hard skills and soft skills owned by students and they are integrated. Baedhowi (in Haryati, 2015) stated that there are four strategies to improve students' hard skills and soft skills, they are by integration in learning, empowering lecturers, optimizing student activities, and collaboration with partners. Therefore, University needs to continue to attempt for developing learning methods which integrate hard skills and soft skills well.

Lloyd and Bahr (in Nadeak, et al, 2020) said that to answer the 21st century challenges, education is required to produce graduates who have several important abilities, one of them is critical thinking. This ability is expected to be achieved by graduates because the important goal of mastering critical thinking is for students to be able to think deeply, logically, able to collect and evaluate evidence with certain disciplines as a result of studying it in the

classroom as a main subject. Mastering critical thinking is very important for students. Widodo, et al (2019) showed a survey conducted by Derek Bok in 2006. The survey notes that more than 90% of teaching staff in America think that critical thinking is the most important goal of undergraduate education. Halpern (in Widodo, et al, 2019) said that mastering critical thinking skills is also highly required in the world of work, where in business or industry that always deals with uncertainty will require people who have high levels of thinking skills. The high-level thinking skills referred here are critical and creative thinking.

One of indicators used by university to maintain the quality of education and learning services provided is by controlling student performance. Prediction of student performance should be routinely done to know the problem happened in student academic achievement as early as possible (Hasana, 2020). The sooner the problem detected is the faster the process of finding a solution. A variable that can be used to measure student performance is the graduation accuracy. Ridwan (2013) said that there are several elements of stakeholder assessment to university which is related to students, including entrance test scores, academic scores, student achievements, competencies mastered by students, and the percentage of students who graduate on time. Student graduation accuracy is very important where it is involved in accreditation process as one of assessment indicators to measure standard of university success in learning process and its implementation.

This study wants to analyze those two variables that both have an important role in maintaining the quality of educational institution performance, they are critical thinking and student graduation accuracy. The results of this study are expected to provide an alternative solution for educational institutions to be able to maintain their academic performance quality through monitoring the students graduation accuracy by paying more attention to the quality of the learning process that focuses on improving the mastery of critical thinking skills. Therefore, this study aims to analyze the relationship between student mastery level in critical thinking skills as one of graduation accuracy factors of students in Teacher Training and Education Faculty, University of Islam Malang using CHAID classification tree algorithm. Ramaswami and Bhaskaran (in Hasana, 2020) said that CHAID is an algorithm that can work effectively with good accuracy in prediction and it is useful in analyzing relationships between influential variables.

Critical Thinking

Critical thinking is one of the skills that must be trained by learners, because these skills are indispensable in life and educators need to help learners to improve these critical thinking skills through supportive learning strategies and methods (Ardina and Agustriana, 2017). Regulation issued by Education and Culture Ministry of the Republic of Indonesia, Number 49 of 2014 about National Standards of Higher Education, Article 6 states that critical thinking is a competency that must be owned by graduates of the Bachelor Program (Santi, et al, 2018). In full, the regulation conveys those graduates of the Bachelor Programs must have general skills, they should be able to apply logical, critical, systematic, and innovative thinking in the context of development or implementation of science and technology that regard and apply humanities values in accordance with their area of expertise.

Surya (2011) states that the definition of critical thinking is an active, persistent activity that needs careful consideration of any belief or knowledge received from various angles of supporting reasons so that conclusions are formed. While Johnson (2014) said that critical thinking is an organized and clear process used in mental activities such as solving problems, making decisions, analyzing assumptions, and making scientific discoveries. In line with that

opinion, Rahmat (in Ardina and Agustriana, 2017) argues that critical thinking has synonyms for decision making, strategic planning, scientific process, and problem solving.

Facione (in Widodo, et al, 2019) argues that special characteristics will appear in a person with critical thinking skills when solving problems. These characteristics include clarifying problems, trying to find relevant information, rationally selecting and applying criteria, solving complex problems in sequence, paying attention to major problems, persisting in adversity, and trying to be careful in considering subjects and circumstances. Meanwhile, according to Ennis (in Widodo, et al., 2019), there are six basic characteristics of critical thinking known as FRISCO (Focus, Reason, Inference, Situation, Clarity, and Overview). The intended focus characteristic is that students are able to determine the concepts used to solve problems, while the second characteristic, namely reason, is that students are able to give reasons about the answers given. The third characteristic, namely inference is where students are able to make conclusions from the available information by making solution steps, while for situation characteristics is when students are able to answer questions according to the context of the problem, can reveal existing events or problems and then solve them. For the characteristics of clarity that is intended here is when students can provide further explanation both in terms of definition and concept linkages, while the last characteristic, namely overview, is where students are able to check what has been found, decided, considered, studied and concluded.

Santi, et al. (2018) expressed several opinions on the importance of critical thinking, one of which states that critical thinking skills are very important intellectual equity for learners. This is because critical thinking can train individuals in choosing the right problem solution. A person's efforts in problem solving, decision-making, analyzing assumptions and scientific discoveries must be based on critical thinking. Individuals who master critical thinking will become more active, have sharp thinking, become sensitive to information and conditions faced, as well as have good manners. The current globalization era makes critical thinking become very important for individuals to have in overcoming various problems. Ease of access to information in the globalization era requires individuals to be able to analyze every information they receive. Problems in globalization era also become increasingly complex, so that the mastery of critical thinking will help in the decision-making process and problem solving with the most appropriate solution. Critical thinking is one of the things that needs to be considered by the world of education to be able to graduate students who can meet global challenges.

Student Graduation Accuracy

Regulation issued by Minister of Education and Culture Number 3 of 2020 established the National Standard of Higher Education (SN Dikti) consisting of educational standards, research standards, and community service standards. The three standards are one-unity that cannot be separated in the implementation of Tri Dharma of Higher Education and ensures that the quality has been established. The National Standard of Higher Education stipulates that the longest period of undergraduate study is 7 years with a student learning load of 144 semester credit units (SKS). Undergraduate students are said to graduate on time if the student study period with the fulfillment of graduate competence is not more than 5 academic years or 10 semesters. This is based on the ideal undergraduate completion time of 4 academic years with the right of temporary dismissal (furlough) of college is a maximum of 2 semesters (Srinadi and Nilakusmawati, 2020).

Aqwil, et al. (2020) conveyed that student graduation accuracy becomes one of indicators in feasibility assessment of an educational institution and there are many things that can affect the length of study period. These influencing factors can arise from internal

factors, which include the students' interests, motivations and abilities, while from external factors include the environment, the area of origin and origin of the school. The characteristics of different students also cause the occurrence of diversity in the length of study taken by students. This is in line with the factors that affect the learning process delivered by Satiman, et al. (in Srinadi and Nilakusmawati, 2020). There are two main factors that affect the learning process, namely intellectual factors indicated by intelligence and intelligence in thinking and acting, such as talent, learning capacity, intellectual intelligence (IQ), and learning outcomes, as well as non-intellectual factors that include all conditions from inside and outside the learner or the surrounding environment related to the person in influencing the ability to think and act, such as learning problems, social, financial, family, organization, friends, learning methods, as well as the environment.

Students are one of the important aspects and play a role in the process of measuring quality and evaluating the success of education at university. This is because students are part of university that will be directly related to stakeholders. University will easily gain stakeholder trust if it is able to produce good graduates and one of the criteria that assess the quality of graduates is the graduation accuracy. Analysis in students' graduation accuracy as one of the elements of measuring student performance with high accuracy and involving influential factors will be useful to identify early problems that may arise. So that the graduation ratio rate to the total number of students will be maintained for the achievement of increasing accreditation values. It can provide information on what factors are dominant in the students' academic performance, especially the level of critical thinking skills.

Method

Quantitative Research

Creswell (2017) explains that quantitative research is the arrangement of methods for testing a particular theory through research about relationships between variables. The variables in quantitative research are measured, so the data in this type of research is in the form of numbers that can be analyzed based on statistical procedures. Creswell (2017) also mentions that in quantitative research it takes assumptions to test theories deductively, prevent bias, control alternative explanations, and be able to generalize and reapply findings obtained for similar cases.

Latief (2014) said that problems in research with quantitative methods are formulated with very clear variables and determined first before the research is done. In quantitative methods, theoretical answers (hypotheses) are prepared first for further testing. All activities in quantitative research are directed to answer questions that have been prepared in the process of testing the hypothesis. Furthermore, Latief (2014) explained that quantitative research methods use data with a numerical measurement scale. This numerical data will be processed using statistical analysis.

Chi-square Automatic Interaction Detector (CHAID)

Gallagher defines CHAID (Chi-square Automatic Interaction Detector) as an estimation technique dependent variables through a repetitive process that tests several independent variables involved in classification, then to be sorted based on the level of chi-square significance to dependent variables. This iterative process in CHAID will stop when no more independent variables are found to be statistically significant to dependent variables (Hasana, 2020). Avilla states that the main target of the CHAID algorithm is to detect interactions in a predictive model (Hasana, 2013). The results of the CHAID classification algorithm are presented in the form of a tree diagram that is structurally arranged as a form of a predictive model where the root part of the tree diagram is the population studied and

the trunk shows the relationship between groups which is the result of the diversity of the response variables involved (Ramaswami and Bhaskaran, 2010).

Sharp et al. (in Hasana, 2020) mention that there are three main elements of CHAID, they are as follows.

1) Chi-square Test

According to Liu and Setiono, chi-square test is a common statistical test to measure differences between variables assuming that the variables found are independent between variables in groups (Ramaswami and Bhaskaran, 2010).

2) Bonferroni Correction

Sharp et.al defines Bonferroni correction as a correcting test used when statistical tests for independence or dependence are performed simultaneously (Hasana, 2013). Kass (in Hasana, 2013) explains that the use of Bonferroni multipliers in CHAID is divided into three based on the measurement scale of variables, namely for ordinal, nominal, and floating scales. Floating variables referred here is a type of predictor variable that has ordinal-scale categories and one category which is not ordinal scale, or in other words the only one category cannot be categorized as ordinal.

3) Merging Algorithm of Categories

Gallagher explained that in CHAID stages, the variables involved will be examined one by one to determine whether they can be combined or separated based on the significance level of chi-square test (Hasana, 2020).

Pertiwi, et al. (2013) show the steps of the CHAID algorithm described by Kass as follows.

1) Performing Cross-tabulation between the categories of each explanatory variable involved with the response variable category.

2) Searching for category pairs of explanatory variables with $2 \times d$ sub-tables (where d is the number of response variable categories) that have the smallest χ^2 . Then, χ^2 resulting from the process will be compared to the predefined χ^2_{α} . If $\chi^2 < \chi^2_{\alpha}$, this category pair will be merged into a new category. The formula for the value χ^2 is as follows.

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^c \left[\frac{(O_{ij} - E_{ij})^2}{E_{ij}} \right]$$

$$E_{ij} = \frac{n_i \cdot n_j}{n}$$

where:

O_{ij} : the number of observations on the i -th row and the j -th column

E_{ij} : the value of observation expectations in the i -th row and the j -th column

r : number of lines

c : number of columns

i : category of i -th explanatory variables

j : category of j -th response variables

3) Checking binary separation for each combined category that contains three or more original categories that have the largest value of χ^2 . If $\chi^2 > \chi^2_{\alpha}$, a new separation is created and returns to stage 2.

4) Calculating χ^{2*} from the explanatory variable that has been combined with the response variable. Next is the examination of the largest value of χ^{2*} and compared to χ^2_{α} . If $\chi^{2*} \geq \chi^2_{\alpha}$, the data will be divided by that category.

5) If there is a separation in stage 4, then return to stage 1 for each data resulted from the separation process.

The chaid algorithm's steps in this study were carried out with the help of IBM SPSS version 25 software. This CHAID method is easier to apply because the algorithm is already widely available in various software.

Data

This study was conducted at Teacher Training and Education Faculty, University of Islam Malang (FKIP UNISMA). Data used here is tracer study data and academic data of FKIP UNISMA students. The tracer study data used here is data from 2017 to 2020 and is focused only in the section about competency mastery information of FKIP UNISMA graduates. So that, not all data from tracer study instruments was used in this study. In the instruments which explore the graduates' competence mastery, there are total of 29 competencies asked which include hard skills and soft skills. All these competencies are summarized in the following table.

Table 1. List of Competencies Involved in Predicting Graduation Accuracy

<i>Hardskill</i>	<i>Softskill</i>
• Knowledge in a field or discipline • Knowledge outside the field or discipline • General Knowledge • English • Internet Skills • Computer Skills • Research Skills • Analytical Skills • Project/Program Management • Ability to Present Ideas/Products/Reports • Ability to Write Reports, Memos, and Documents	• Critical thinking • Learning ability • Communication ability • Working Under Pressure • Time Management • Working independently • Working in a Team/Working Together • Problem solving ability • Negotiations • Tolerance • Adaptability • Loyalty • Integrity • Working with People from Different Cultures and Backgrounds • Leadership • Responsibility • Initiative • Ability to Continue A Lifetime Learning

Student graduation accuracy data of FKIP UNISMA is obtained from the academic section office by checking study period data (in semesters) from graduates who filled out tracer study questionnaires. There were 373 graduates who filled out the questionnaire during the specified time span. This checking process shows that there are 308 students who graduated on time and the other 65 students that did not graduate on time.

All competencies obtained from tracer study instruments are used as variables to analyze the graduation accuracy of FKIP UNISMA students using the CHAID method. These variables have their own categories as in the table below.

Table 2. The CHAID Variables

Variable	Notes	Categories
Graduation Accuracy (Waktu_Lulus)	• Study period ≤ 4 years is defined as graduating on time • Study period > 4 years is defined as not graduating on time	1= graduating on time; 2=not graduating on time
Knowledge in a field or discipline (Disiplin_Ilmu), General Knowledge (Pengetahuan_Umum), English	At what level is this competence mastered?	1=Very High; 2=High;

(Bahasa Inggris), Internet Skill (Internet), Computer Skill (Komputer), Critical Thinking (Berpikir Kritis), Learning ability (Belajar), Tolerance (Toleransi), Working with People from Different Cultures and Backgrounds (Work_Others),	3=Enough; 4=Low; 5=Very Low
Knowledge outside the field or discipline (NONDisiplin_Ilmu), Research Skills (Riset), Communication ability (Komunikasi), Working Under Pressure (Underpressure), Time Management (Time_Management), Working independently (Bekerja_Mandiri), Working in a Team/Working Together (Bekerja_Tim), Problem solving ability (Problem_Solving), Negotiations (Negosiasi), Analytical Skills (Analisis), Adaptability (Adaptasi), Loyalty (Loyalitas), Integrity (Integritas), Leadership (Kepemimpinan), Responsibility (Responsible), Initiative (Inisiatif), Project/Program Management (Project_Management), Ability to Present Ideas/Products/Reports (Idea_Presentation), Ability to Write Reports, Memos, and Documents (Report_Writing), Ability to Continue A Lifetime Learning (Longlife_Edu)	0=Not Answering; 1=Very High; 2=High; 3=Enough; 4=Low; 5=Very Low

At what level is this competence mastered?

Findings and Discussion

The test using CHAID algorithm aims to analyze the relationship between mastery levels of all competencies obtained from tracer study instruments as a factor for graduation accuracy of FKIP UNISMA students. However, in this article, the discussion will be focused on one of the abilities, namely critical thinking, by analyzing the value of the significance of the CHAID algorithm results on the graduation accuracy of FKIP UNISMA students. The graduation accuracy criteria used in this study were determined for students whose study period was less than or equal to 4 years (≤ 8 semesters), with no furlough period. This criterion was chosen to be able to maintain the quality standards of FKIP UNISMA graduates at their best. This is also the basis for making the category of Graduating on Time as a test target of the CHAID algorithm. Because this CHAID analysis wants to know what competencies should be mastered by students of FKIP UNISMA that can support the graduation accuracy, so that later this information will be able to be used to improve the quality of teaching and learning held at FKIP UNISMA.

There are 29 competencies involved as independent variables in this CHAID analysis. All these competencies will be classified by CHAID to determine the characteristics of FKIP UNISMA students who graduate on time. Automatically, all of these competencies will be checked by CHAID to determine which is the best predictor for graduation accuracy based on their significance value. However, because this study involves FKIP UNISMA students where the main graduate profile is as a prospective teachers, this study determines the variable of mastering knowledge in the field/discipline as a variable that must be mastered by FKIP UNISMA students. In other words, the variable of mastering knowledge in the field/discipline is used as the first predictor that is deliberately chosen, then CHAID will continue automatically to find out the other predictors.

CHAID iterative process in this study showed that from 29 variables of competency mastery, there were 5 predictors which are significant to graduation accuracy variable. They are mastering knowledge in the field/discipline that has been determined before, competency of working under pressure, competency of mastering general knowledge, competency of critical thinking, and competency of English. CHAID analysis model is briefly presented in the following table.

Table 3. CHAID Analysis Model Summary

Specifications	Growing Method	CHAID
	Dependent Variable	Waktu_Lulus
	Independent Variables	NONDisiplin_Ilmu, Pengetahuan_Umum, Bahasa_Ingggris, Internet, Komputer, Berpikir_Kritis, Riset, Belajar, Komunikasi, Underpressure, Time_Management, Bekerja_Mandiri, Bekerja_Tim, Problem_Solving, Negosiasi, Analisis, Toleransi, Adaptasi, Loyalitas, Integritas, Work_Others, Kepemimpinan, Responsible, Inisiatif, Project_Management, Idea_Presentation, Report_Writing, Longlife_Edu, Disiplin_Ilmu
Results	Independent Variables Included	Disiplin_Ilmu, Underpressure, Pengetahuan_Umum, Berpikir_Kritis, Bahasa_Ingggris
	Number of Nodes	11
	Number of Terminal Nodes	6
	Depth	3

Table 3 above provides information that the decision tree compiled by the CHAID algorithm in this study has 6 terminal nodes. It means that there will be 6 segments of student graduation accuracy classification based on 5 selected independent variables. The decision tree obtained from CHAID algorithm in this study presented as follows.

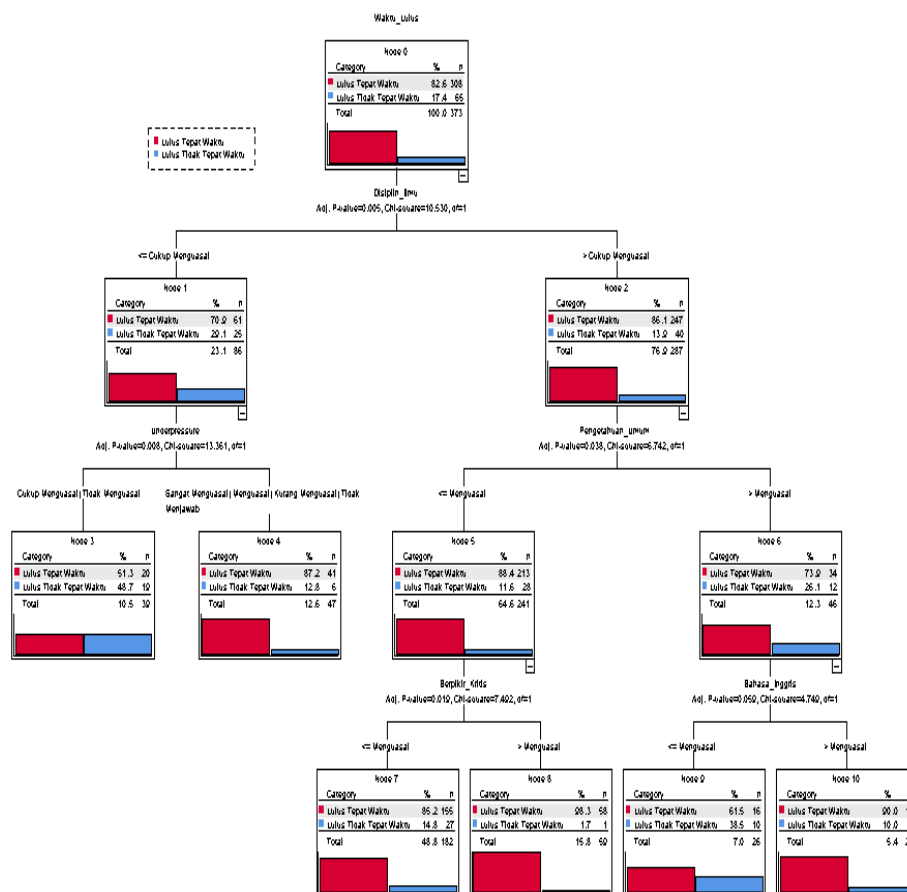


Figure 1. Tree Diagram of CHAID Classification on Graduation Accuracy of FKIP UNISMA Students

The CHAID decision tree above describes the entire segments of the graduation accuracy classification of FKIP UNISMA students based on the mastery level of the 5 selected competencies. The final six nodes (terminal nodes) show that there are 6 characteristic structures of FKIP UNISMA students who graduated on time. The six nodes show a cluster of possible classification segments that can predict students' graduation accuracy. Further, to focus more on critical thinking, the observation will be on node 7 and node 8 as in the figure below.

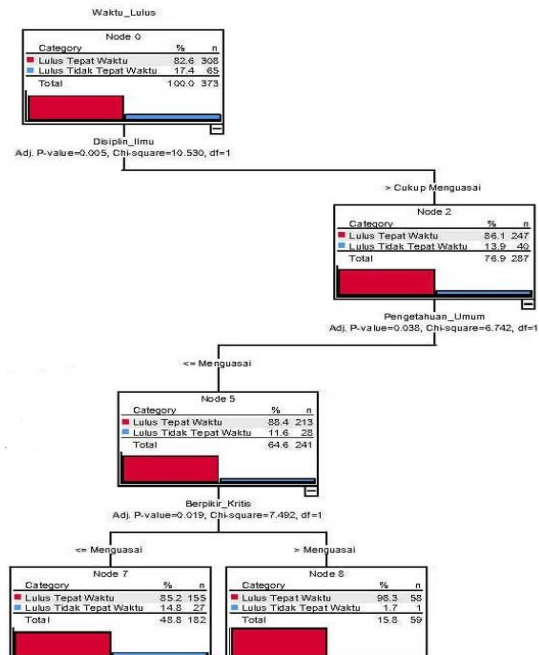


Figure 2. Node 7 and Node 8 of Tree Diagram of CHAID Classification on Graduation Accuracy of FKIP UNISMA Students

Figure 2 shows that critical thinking mastery has an Adj P-value of 0.019, where it is < 0.05 , and it means that critical thinking mastery has a significant relationship with graduation accuracy based on the chi-square test. This critical thinking ability is significant in characterizing FKIP UNISMA students who graduate on time according to set of characteristics which the terminal nodes are in node 7 and 8. The characteristic arrangements of students who graduate on time based on competency mastery explained by node 7 and 8 are shown in the following table.

Table 4. Characteristics of Competency Mastery of FKIP UNISMA Students Who Graduated on Time Explained on Node 7 and 8

Node	Characteristics
Node 8	Students who graduated on time have characteristics in mastering knowledge in a field/discipline at least at the level of high, mastering general knowledge at the level of high, as well as mastering critical thinking at the level of very high.
Node 7	Students who graduated on time have characteristics in mastering knowledge in a field/discipline at least at the level of high, mastering general knowledge at the level of high, as well as mastering critical thinking at least at the level of high.

Table 4 shows that FKIP UNISMA students who graduate on time have the characteristics of critical thinking mastery at the level of high and very high. This shows that, to be able to graduate on time, FKIP UNISMA students must pay more attention to master critical thinking in addition to also paying attention to master knowledge in the fields/disciplines studied in university and also master general knowledge.

In theory, critical thinking do have a positive relationship with learning outcomes. As stated by Nadeak et al. (2020) in the results of their research which explained that the examination of relationships between variables showed that there is a positive and significant relationship between students' critical thinking skills and learning achievement. It means that the higher the student's critical thinking skills, the better learning achievement. Furthermore, if the student learning achievements can always be maintained to be good in each semester, then it can be predicted that there will be no additional study period and will be able to graduate on time or even less than the standard study period of 8 semesters.

The CHAID analysis that has been done in this study has a good accuracy value as shown in the IBM SPSS 25 output table below.

Table 5. Accuracy of CHAID Algorithm in Analyzing Graduation Accuracy of FKIP UNISMA Students Based on Competency Mastery

		Risk		
		Estimate	Standard Error	
		0.174	0.020	
Classification				
		Predicted		
		Graduating on Time	Not Graduating on Time	Percent Correct
Observed				
Graduating on Time		308	0	100.0%
Not Graduating on Time		65	0	0.0%
Overall		100.0%	0.0%	82.6%
Percentage				
Growing Method: CHAID				
Dependent Variable: Waktu Lulus				

Table 6 above shows that the Standard Error value of the CHAID test in this study is 0.020 with an estimated error risk of 17.4%. The analysis result accuracy of CHAID algorithm in predicting graduation accuracy of FKIP UNISMA students based on competency mastery is 82.6% or very good.

Conclusions and Suggestions

Based on the above description, it can be concluded that one of the variables resulted by CHAID which has a significant relationship with graduation accuracy of FKIP UNISMA students is critical thinking skill with a significance value (Adj P-value) of chi-square test equal to 0.019. The analysis accuracy of CHAID algorithm is quite good, where the accuracy rate of the test reaches 82.6%. The results of this study can further be used as a consideration for FKIP UNISMA so that its learning process can be improved to focus more on mastering critical thinking skills. This aims to keep improving the ratio of graduate number and the quality of FKIP UNISMA graduates as a quality benchmark for the institutional performance.

CHAID algorithm can then be applied in mining other academic data with more varied variables and can be developed for a wider research scope so that institutional performance evaluation can be carried out based on accurate research results.

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