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ANALYSIS OF STUDENT PERCEPTIONS OF WORKING GROUP PROJECTS IN PROJECT COURSES USING NON-PARAMETRIC LEARNING MODEL

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Abstract

Students' perceptions of implementing a learning model program must be understood. Students' lack of understanding when participating in learning programs is the starting point of their learning failure. This research explores student perceptions about the Project Work Group Based Learning (PWGL) model implemented in Project courses. Project courses provide a bridge for students to be productive when they graduate. The main problem is how far a mismatch exists between students' perceptions of the learning model being implemented. The Method used is a descriptive-quantitative approach with survey techniques. Data analysis uses a Non-Parametric Learning Model, namely the K-Nearest Neighbor (k-NN) algorithm and Decision Tree. The instrument is in the form of a questionnaire, which is distributed to respondents via Google form media. The results of data analysis show that the gap between the implementation of PWGL and student perceptions is 23.6%, which originates from the target dimensions of the learning program = 23%, PWGL principles = 27%, student creativity development = 17%, and real needs of industry partners = 25 %. Thus, one-third (1/3) of the implemented PWGL model parameters are poorly understood by students. The author further suggests that those in authority socialize about this learning model.

Keywords: Perception, PWGL, Misalignment, k-NN and Decision Tree.

INTRODUCTION

Equipping vocational education graduates with work competencies is a responsive step to meet the workforce demands of businesses and industries. This is one of the missions of Polytechnic institutions in Indonesia. These institutions have developed several educational programs incorporating learning models that simulate job processes. These programs allow students to explore their theoretical knowledge through project-based cases, interact effectively with their work teams, and respond to the needs of partners and prospective users on the broader community.

This research explores a case involving a Group Project learning model applied to the Project course in the Informatics Engineering study program at Indramayu State Polytechnic, Indonesia. In this course, students undertake case studies on application product development based on partners' needs to create solutions. They explore their abilities in developing object-oriented application products that can provide problem-solving solutions for partners and understand market needs to create application product solutions sourced from creative ideas to address issues in society and industry. However, this study focuses on students' perceptions of the implemented learning model. Recently, k-Nearest Neighbors (k-NN) and principal component analysis (PCA) is a simple, non-parametric learning algorithm for machine learning classification model. The principle behind k-NN and PCA is to find predefined samples closest in the distance to the new point. In our research, we apply this kind of non-parametric learning for (1) identify gaps in the alignment between student perceptions and the objectives of the project course curriculum, (2) identify gaps in the alignment between the principle of Project Work Group-Based Learning (PWGL) and their implementation based on student perceptions, (3) Identify gaps in the alignment between the product projects undertaken and the enhancement of creativity based on student perceptions, (4) Identify misalignment gaps between the product projects undertaken and the industry needs based on student perceptions.

LITERATURE REVIEW

Project Work Group Based Learning (PWGL)

Creativity is an individual's ability to generate novel ideas or products based on their concepts. According to Kristin in Nugraha et al. (2018, p. 11), "Creativity is the ability of an individual to produce something new, whether in the form of a product or an idea, which can be beneficial." Similarly, Sumanto in Nurmaida (2019, p. 11) describes it as the capacity to generate unique ideas or tangible works that differ significantly from existing ones. These definitions underscore creativity as a skill essential for learners to innovate and create valuable outcomes.

Creativity varies among learners while every individual possesses the potential for creative thinking. Hayati et al. (2019, p. 116) note the diversity in levels of creativity among students, with some demonstrating quick adaptability in learning, actively engaging in questioning, problem-solving, and confidently expressing their opinions. Titu, referenced in Utami et al. (2018, p. 544), categorizes creativity into fluency, flexibility of thinking, elaboration, and originality, emphasizing the multifaceted nature of creative abilities. Project Based Learning (PBL), as defined by Thomas in Laksono (2018, p. 70), engages students in problem-solving tasks and meaningful activities, allowing them to construct learning experiences and produce tangible outcomes autonomously. This approach fosters creativity by encouraging students to address real-world challenges through collaborative efforts, as Sari (2017, p. 6) highlighted, which emphasizes PBL's role in enhancing creativity, collaboration, and scientific attitudes among students.

In addition to fostering creativity, PBL cultivates essential skills such as critical thinking, communication, and teamwork. Vogler et al. (2018) discuss the importance of equipping students with both hard skills—cognitive knowledge and professional expertise—and soft skills—problem-solving and teamwork abilities (Casner-Lotto & Barrington, 2006). This dual focus prepares students to thrive in competitive academic and professional environments where innovation and collaboration are crucial. In conclusion, integrating project-based Learning in educational settings enhances students' creativity and critical skills development, preparing them to excel in diverse and challenging environments.

Non-Parametric Learning Model

Non-parametric metrics such as Euclidean distance, Manhattan distance, and mean squared error have been widely used to measure patterns between two test samples or distributions. For example, k-Nearest Neighbors (k-NN) utilizes Euclidean distance to determine which cluster or class a new sample belongs to. Similarly, Principal Component Analysis (PCA) is a dimensionality reduction technique that projects data onto a lower-dimensional space while preserving as much variance as possible, and the distance between data points in the original space can be computed using Euclidean distance. Inspired by the advantages of non-parametric metrics, we adopt these distance measures to evaluate the gaps in alignment between student perceptions and the objectives of expected outcomes. We aim to identify patterns and discrepancies between the needs and expectations of course learning measurements.

RESEARCH METHODOLOGY

a) Indicator

This study adopts a descriptive-quantitative approach, employing survey methodology with questionnaire techniques to gather data. The research explores students' perceptions of Project Work Group Based Learning (PWGL) implemented in the Project course. The study examines four dimensions:

1) *Course objectives* are assessed through indicators such as learning targets, scheduled timeline objectives, learning experiences, accuracy of learning experiences, precision of learning targets, learning success, and clarity of learning objectives.
2) *PWGL principles* are evaluated using indicators including scheduled timeline targets, faculty facilitation role, autonomy, method-compliant scheduling, and collaboration.
3) *Development of creativity* encompasses indicators like the flexibility of thinking, creation of new concepts, elaboration, originality, method-compliant scheduling, and collaboration.
4) *Real-world needs,* covering indicators such as industry partner requirements, learning experience needs, time benefit needs, and confidence-building needs.

Measurement is conducted on an ordinal scale using responses in the questionnaire: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), scored respectively as SA=4, A=3, D=2, and SD=1. Before the study, validity, and reliability tests were conducted to ensure questionnaire quality. Validity was assessed using Pearson Product Moment Correlation, while reliability was assessed using Cronbach's Alpha. The study involved 61 students enrolled in the Project course at the Department of Informatics Engineering, State Polytechnic of Indramayu.

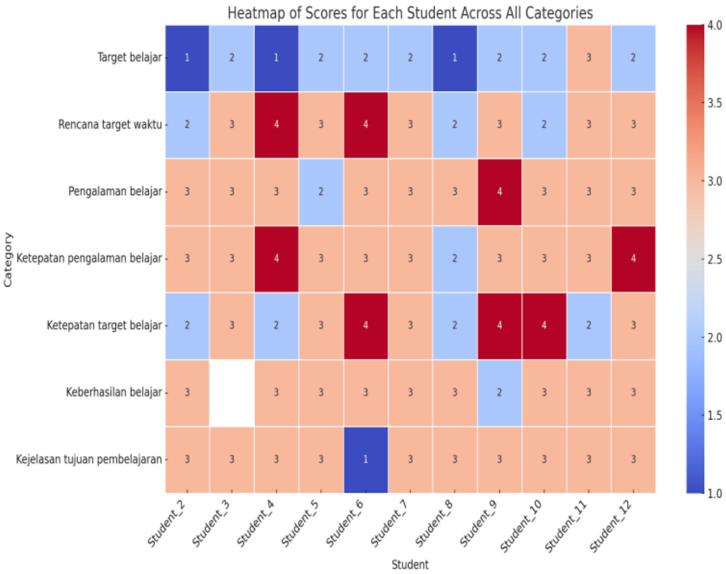


Fig 1: Heatmap scores of students question

ANALYSIS AND INTERPRETATION

b) Results

Based on 61 respondents' data, Figure 2 provides an overview of the proportion of students who participated in this study.

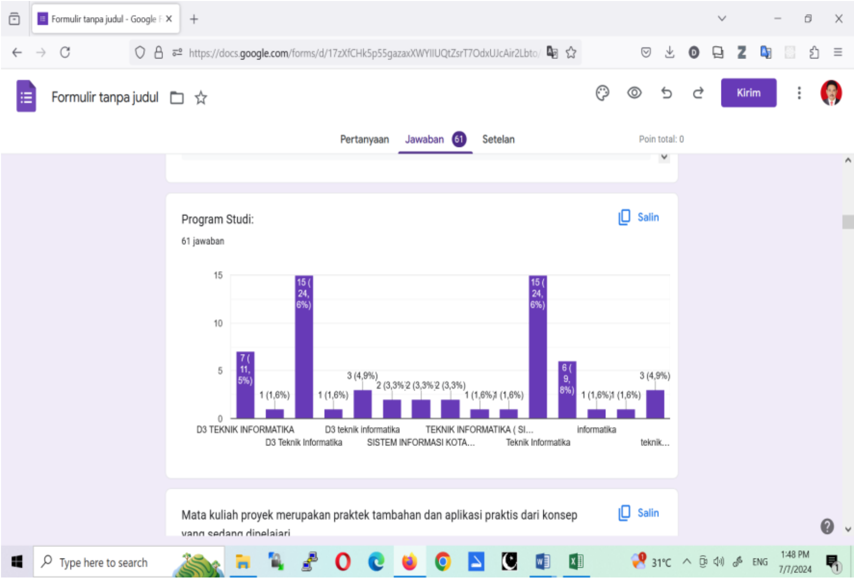
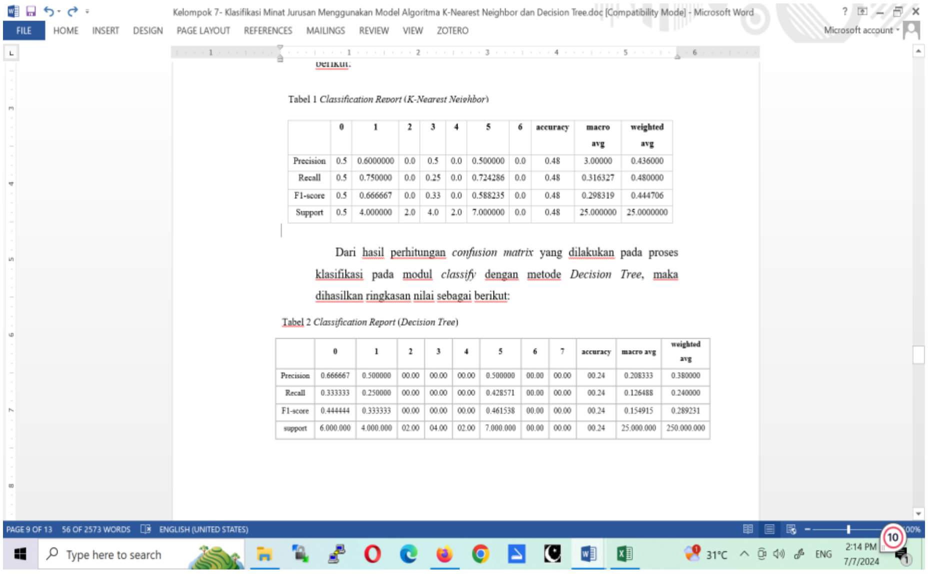


Fig 2: Proportion of Respondents

The calculation results *in a confusion matrix* carried out in the process *classifi*ed with method *K-Nearest Neighbor*, then produced with the values shown in Table 1 below:

Table 1: *Classification Report* (*K-Nearest Neighbor*)



Tabel 1 *Classification Report* (*K-Nearest Neighbor*)

	0	1	2	3	4	5	6	accuracy	macro avg	weighted avg
Precision	0.5	0.6000000	0.0	0.5	0.0	0.500000	0.0	0.48	3.00000	0.436000
Recall	0.5	0.750000	0.0	0.25	0.0	0.724286	0.0	0.48	0.316327	0.480000
F1-score	0.5	0.666667	0.0	0.33	0.0	0.588235	0.0	0.48	0.298319	0.444706
Support	0.5	4.000000	2.0	4.0	2.0	7.000000	0.0	0.48	25.000000	25.0000000

Dari hasil perhitungan *confusion matrix* yang dilakukan pada proses klasifikasi pada modul *classify* dengan metode *Decision Tree*, maka dihasilkan ringkasan nilai sebagai berikut:

Tabel 2 *Classification Report* (*Decision Tree*)

	0	1	2	3	4	5	6	7	accuracy	macro avg	weighted avg
Precision	0.666667	0.500000	00.00	00.00	00.00	0.500000	00.00	00.00	00.24	0.208333	0.380000
Recall	0.333333	0.250000	00.00	00.00	00.00	0.428571	00.00	00.00	00.24	0.126488	0.240000
F1-score	0.444444	0.333333	00.00	00.00	00.00	0.461538	00.00	00.00	00.24	0.154915	0.289231
support	6.000.000	4.000.000	02.00	04.00	02.00	7.000.000	00.00	00.00	00.24	25.000.000	250.000.000

The results of the confusion matrix calculation carried out in the classification process in the classifying module using the Decision Tree method, a summary of values is produced as shown in Table 2.

Based on the results of the two tables *classification report* in Table 1 and Table 2, you can see a comparison of accuracy between models *K-Nearest Neighbor* with *Decision Tree*. The histogram shown in Figure 3 is produced.

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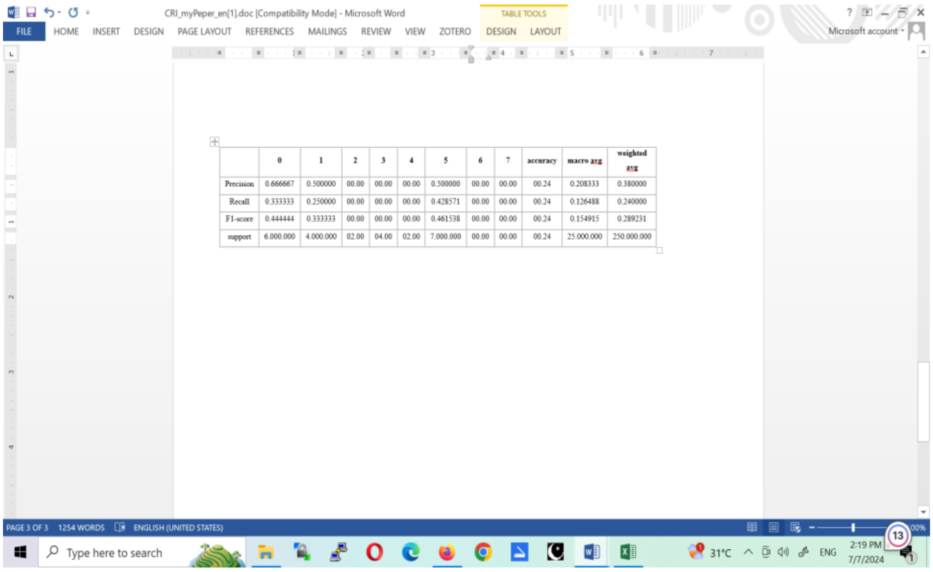
Table 2: *Classification Report* (*Decision Tree*)



	0	1	2	3	4	5	6	7	accuracy	macro avg	weighted avg
Precision	0.666667	0.500000	00.00	00.00	00.00	0.500000	00.00	00.00	00.24	0.208333	0.380000
Recall	0.333333	0.250000	00.00	00.00	00.00	0.428571	00.00	00.00	00.24	0.126488	0.240000
F1-score	0.444444	0.333333	00.00	00.00	00.00	0.461538	00.00	00.00	00.24	0.154915	0.289231
support	6.000.000	4.000.000	02.00	04.00	02.00	7.000.000	00.00	00.00	00.24	25.000.000	250.000.000

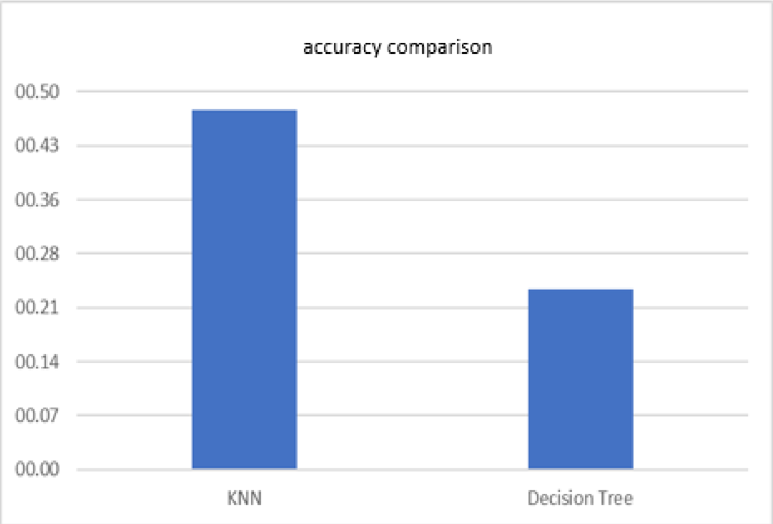


Fig 3: Histogram Comparison of Model Accuracy Values *KNN* and *Decision Tree*

The results of the confusion matrix calculation using the K-Nearest Neighbor method in Table 1 produce accuracy values of 0.48, precision 0.6, recall 0.75, f1-score 0.67, and support 4.0. This means that the value resulting from data comparison, or what is defined as whether it is correct, is attack or normal data; of the total data, only 48% is defined as correct.

If we look at the level of accuracy between the information requested and the answers given, the system produces a value of 60%, which means it is not accurate. In this test, it can be said that the classification quality was quite successful because it obtained relatively high precision and recall values.

The performance of the K-nearest neighbor model is very dependent on the K value. Based on the results of testing the k value from k=1 to k=10, the best accuracy result is 0.48 or 48%, which can be seen in Figure 4.

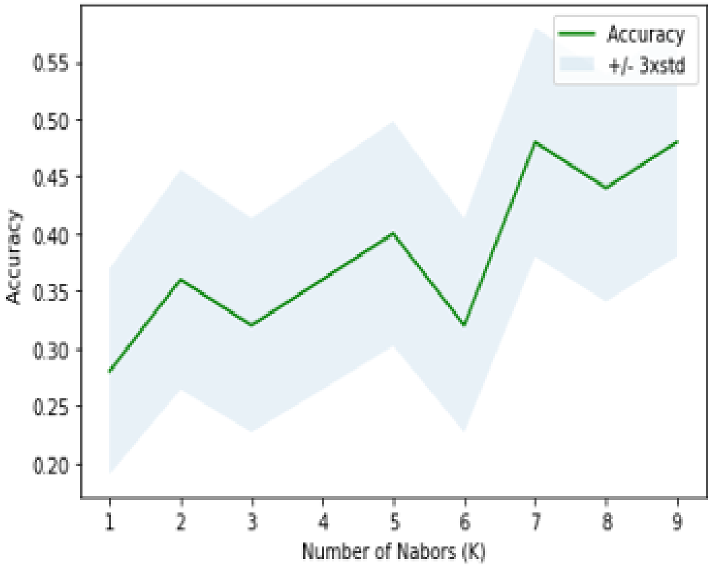


Fig 4: Visualization of Testing Values k=1 to k=10

The results of the confusion matrix calculation using the K-Nearest Neighbor method in Table 2 produce accuracy values of 0.24, precision 0.67, recall 0.33, f1-score 0.4, and support 6.0. This means that the value resulting from data comparison, or what is defined as whether it is correct, is attack or normal data; of the total data, only 24% is defined as correct. If we look at the level of accuracy between the information requested and the answers given, the system produces a value of 67%, which means it is not accurate. In this test, it can be said that the quality of the classification was less successful because low precision and recall values were obtained.

Based on the calculation results, the accuracy results obtained in the K-Nearest Neighbor model are 0.48. The accuracy obtained in the Decision Tree model is 0.24. Both models have low accuracy values. Imbalance data cause the low accuracy value in this model.

Unbalanced data is a situation where the distribution of data classes is unbalanced; the number of one data class (instance) is less or more than the number of other data classes. Decision Trees and K-nearest neighbors perform poorly when working on data with highly imbalanced classes.

The K-Nearest Neighbor and Decision Tree methods cannot handle class imbalance problems [9]. However, the KNN model has much higher accuracy than the Decision Tree model.

c) Data Analysis of Learning Target Dimensions

1. *Learning Target Dimensions*

In the dimensions of the target or objective of the Project course program by implementing the PWGL model, the author reviews the indicators aspect: learning target, time target plan, learning experience, the accuracy of the learning experience, the accuracy of learning targets, learning success, and clarity of learning objectives.

Calculations using the k-NN algorithm with testing data = [3,3,3,2,4,2,3] show the information in table 3.

Table 4: Calculation of k-NN learning target dimensions

Euclidean Distance	Urutan Jarak	k=4	Status
2.65	1	Ya	Selaras
3.32	2	Ya	Selaras
3.87	3	Ya	Selaras
6.24	4	Ya	Selaras
6.48	5	Tidak	Kurang Selaras
7.14	6	Tidak	Kurang Selaras
7.14	6	Tidak	Kurang Selaras

The lack of alignment between learning program targets and students' perceptions of these targets is shown in indicators of accuracy of learning targets, learning success, and clarity of learning objectives. Meanwhile, aligned indicators of this dimension include learning targets, planned time targets, learning experiences, and accuracy of learning experiences.

The best way to achieve the learning objectives of this PWGL model and reduce the misalignment factor is to tell students what is expected of them. At the start of the project, provide rubrics and handouts outlining how the project will be graded, the products they will have to submit, and how they will have to work in groups.

2. *Dimensions of PWGL Principles*

In the dimensions of the principles of the PWGL model, the author reviews the indicator aspects: time target schedule, Lecturer as facilitator, Independence, Schedule according to Method, and Collaboration. Figure 5 visualizes respondent data from the perception of this dimension indicator.

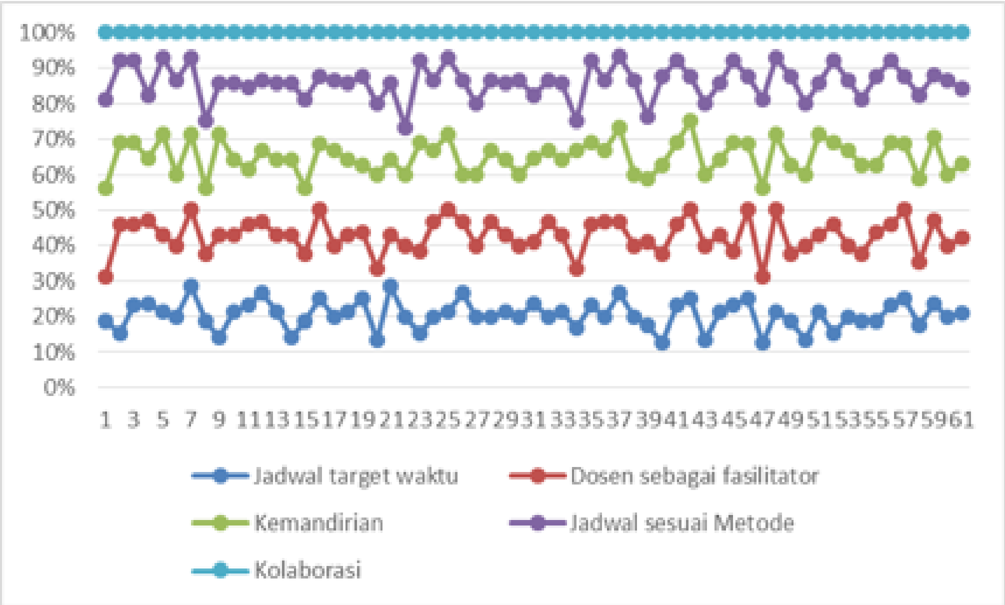


Fig 5: Dimension of PWGL Princips

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The gap in incongruity between the PWGL principles and their implementation is 27%. The percentage of incongruity comes from the indicators: Time target schedule = 7%, Lecturer as facilitator = 31%, Independence = 29%, Schedule according to Method = 22%, and Collaboration = 46%. The biggest contributor to this dimension is the Collaboration indicator.

The PWGL model facilitates students' learning to have creative problem-solving skills, the importance of collaboration, how to find the right resources for the job, how to build learning in project management skills, and how to use relevant technology to find resources, communicate, and produce the final product that suit partner needs. The research results show that collaboration within teams still has large incongruities.

3. ***Dimensions of Student Creativity Development***

The PWGL model, which was implemented about student perceptions regarding the development of their creativity, obtained an incongruity score of 17%. The gap The percentage of incongruity comes from the indicators of flexibility of thinking=3%, creating something new=26%, elaboration=11%, originality=13%, creating something new=20, and Schedule according to method=26%. The most significant contributor to this dimension is the indicator of creating something new and the Schedule according to the Method.

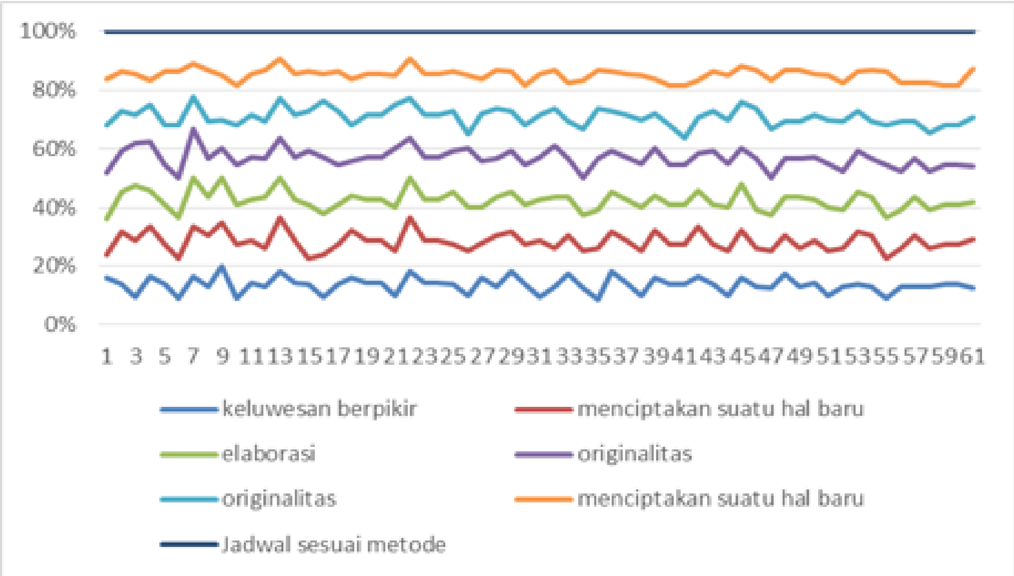

Fig 6: Indicators of Student Creativity Development

Students learn best when they study something that captures their imagination and interest. Regardless of the final product, students should have as much autonomy as possible in what they create and how. They must learn how to communicate their ideas in groups and individually and really bring their passion to the project.

Students can organize their own knowledge to solve problems and seek various solutions, encouraging them to think creatively. The problem in the dimension of developing student creativity in project courses with the implementation of the PWGL model is creating something new and Scheduling according to the Method.

4. *Dimensions of Real Needs from Industrial Partners*

The product theme developed by students in this Project course refers to the needs of industrial partners manifested in the application or software features that students will develop as a learning medium. Thus, it is assumed that the application product developed meets real needs. The indicators designed in the PWGL model for this dimension still have a mismatch with student perceptions of 25%, which means that a quarter of the ideal conditions for this dimension are still poorly understood by students. The percentage of inconsistency comes from the industry partner needs indicator = 18%. need for learning experience = 9%, need for benefits of learning = 23%, need for benefits of study time = 23%, and need for self-confidence = 27%. An indicator of self-confidence in producing products that suit the needs of industry partners where student perceptions have the lowest level of disharmony.

CONCLUSION

Based on the results of research on student perceptions of the implementation of Project Work Group-Based Learning (PWGL) in Project courses using the K-Nearest Neighbor and Decision Tree Algorithm models, it can be concluded that the K-Nearest Neighbor method has an accurate match based on the results of the misalignment gap between student perceptions and The PWGL lecture program obtained a value of k=7 of 48%. In comparison, for the classification method using the Decision Tree C4.5 algorithm, it was 24%. This proves that the KNN algorithm has a higher and better accuracy value for classifying student perceptions of PWGL in Project Courses. Students' perceptions of the Project Course targets show a 29.3% mismatch with their ideal grades. The gap between the targets of the Project course lecture program is 35%, and its implementation is based on student perceptions. The gap between the PWGL principles and their implementation is 32% based on student perceptions. The gap between PWGL principles and their implementation is 37%. The relevance gap between the product projects carried out is 24% towards developing student creativity. The gap between product projects carried out by students and the real needs of industry as partners is 33%. Thus, the gap between the implementation of PWGL and student perceptions is 28.6%.

RECOMMENDATION

Several things that need to be developed in further research with the same environmental space are:

1) More training data and more diverse attributes are needed to increase accuracy.
2) Using other classification calculation methods such as K-Means, Support Vector Machine (SVM), Naïve Bayes, and AdaBoost.
3) Using SMOTE (Synthetic Minority Oversampling Technique) to overcome data imbalance.

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