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The Correlation Analysis Between 4C Skill Components in High School Mobility System Material with GGE-JAS Learning Model

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Abstract

This research aims to analyze the correlation of 4C skill aspects based on students' achievement in each aspect through GGE-JAS learning model. This research was conducted at SMA N 1 Tengaran, Semarang Regency with a quasi-experimental model and a non-equivalent group research design. The data collection method used was with test and non-test instruments. The results of this research in critical thinking skills in control class had an N-gain result of 0.36 in the low category and the experimental class was 0.53 in the medium category. This shows a striking difference before and after treatment in each class, so that the GGE-JAS model was effective. After the implementation of the GGE-JAS model in the experimental class, the achievement of critical thinking indicators was 73% in good category, collaboration skills was 83% in a very colaborative category, communication skills was 74.8% in a communicative category and creative thinking skills was 71.32% in creative category. The results of the correlation analysis stated that collaboration skills had a significant relationship with communication skills with t-value of 3.22 while creative thinking skills had a significant relationship with critical thinking skills with t-value of 2.04. The conclusion of this research is that GGE-JAS model is effective to improve students' 4C skills in the mobility system material for class XI MIPA SMA N 1 Tengaran, Semarang Regency and students' collaboration skills are significantly positive related to students' communication skills, while students' creative thinking skills have a significant positive relation with students' critical thinking skills.

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INTRODUCTION

The Kurikulum Merdeka is the main structure that must be found in school to carry out learning activities (Suryaman, 2020). This Kurikulum merdeka is designed by adapting various indicators of 21st century skills, 4C abilities, including creative thinking, critical thinking and problem solving, communication, and collaboration. In classroom learning, teachers can stimulate several 4C components that are in accordance with pelajar Pancasila profil from the aspects of collaboration skills, critical reasoning, creative thinking and student communication, both from cognitive assessments with tests and non-tests such as questionnaires and other assessment instruments (Zuriah & Sunaryo, 2022). A learning model is needed so that students can understand the basic concepts of the material structure and function of the body organs being studied and can stimulate the emergence of 4C skills in the pelajar pancasila profil optimally in classroom learning activities, so that the effectiveness and learning objectives can be achieved properly (Simorangkir & Napitupulu, 2020).

One of the appropriate models to improve student understanding and maximize the formation of affective components in students in the classroom is the Group to Group Exchange model and is combined with the Jelajah Alam Sekitar approach to encourage students to utilize existing learning resources. The combination and modification of this learning model is called the GGE-JAS model. This combination aims to minimize deficiencies in both the syntax and implementation of learning in a model by combining components from a learning approach. The combination of the syntax of the GGE learning model with the JAS components produces a new syntax including exploration, team construction and discussion, presentation, QnA and Evaluation. The GGE-JAS model allows the formation of a solid learning atmosphere (collaboration) between friends by forming study groups and exchanging information (Fajriana, 2022).

A learning model is effective if it meets the criteria for achieving indicators in each aspect of 4C. The achievement of this indicator indicates that the teaching and learning process is carried out well through the model used and students are said to be skilled in the aspects of critical thinking skills, collaboration skills, communication skills and creative thinking skills.

Critical thinking is a reflective thinking ability that focuses on decision-making patterns about what should be believed, should be done and can be accounted for which results in interpretation, analysis, evaluation and inference, and presentation using evidence, concepts, methodologies, criteria, or contextual considerations that form the basis for decision-making (Ennis, 2011). A good learning model is designed to develop critical thinking skills through a series of activities involving data collection, analysis, and decision-making (Redhana, 2013). This GGE-JAS model facilitates students with constructive discussions with fellow friends in accordance with scientific and logical principles to make decisions, as well as activities to analyze ideas and information that they have obtained to draw conclusions. So in this model it facilitates students to collaborate and build constructivist learning experiences.

The concept of collaboration is the most prominent concept and is often used as a reference in active learning in the classroom. Pancasila students have collaborative skills, namely the ability to work together with others and show a positive attitude towards others (Kemendikbudristek, 2022). In terms of collaborative skills and being closely related to other group members, communication skills are needed so that discussions can run smoothly.

Communication skills are students' ability to interact well in social and academic situations. This includes the ability to listen, understand, and express thoughts and feelings effectively (Pamungkas & Wantoro, 2020). The planned communication motives of students are in the form of expressing opinions, discussing, asking questions, and understanding problems in people's lives. This supports the understanding of learning material (Noviyanti, 2011). Collaboration and communication activities with the GGE-JAS model require students to create a work or product so that creative thinking skills are needed.

Students' creative thinking skills are the ability to generate new, innovative, and useful ideas. Creativity involves the ability to do unusual concept pairings, find unique solutions to problems, and develop out-of-the-box ideas (Hidayah & Mushoddik, 2023). Key elements of creativity consist of generating original ideas and producing original works and actions and having the flexibility of thinking in finding alternative solutions to problems.

Based on observations at SMA N 1 Tengaran, students generally find it difficult to understand material related to structure and function due to the complexity of the material. The scope of the structure and function material for grade XI SMA is broader because it includes organs and their functions as well as disorders that can

affect the organ system. The learning methods applied are also not fully student-centered learning. So it is necessary to conduct evaluations and innovations to overcome these problems, one of which is by using the right learning model (Simorangkir & Napitupulu, 2020).

Efforts and solutions that can be made to overcome these student difficulties are to accustom and stimulate students to carry out active activities during the learning process with the GGE-JAS learning model. This model facilitates students to collaborate and discuss so that it will make it easier for students to practice and have learning experiences to think critically, collaborate, communicate and think creatively. The GGE model has been shown to enhance student learning outcomes in various subjects. The GGE model promotes active participation among students (Kurniawan, 2019). By distributing materials, conducting group discussions, and presenting findings, students become more engaged and interactive during the learning process (Hasanah, 2021).

Therefore, the purpose of this research is to analyze the correlation between aspects of 4C skills in students with the GGE-JAS learning model on the mobility system material of class XI MIPA SMA N 1 Tengaran. With the modification and innovation of a learning model is able to help students learn the structure and function material and improve these 4C skills.

METHOD

This research was conducted at SMA N 1 Tengaran, Kabupaten Semarang in second semester in the academic year of 2023/2024. The population of this research is students of grade XI MIPA SMA N 1 Tengaran, Kabupaten Semarang consisting of 3 classes that was class XI MIPA 6, XI MIPA 1, and XI MIPA 7. This research is an experimental research with a quasi-experimental model with non-equivalent control group design. The sample used was 3 classes, class XI MIPA 6 as control class, while XI MIPA 1 and XI MIPA 7 as experimental class. The consideration of the students in total was 108 students. The sampling technique is purposive sampling.

There are 3 steps in this research, such as the preparation stage, the implementation stage and the evaluation stage. The preparation stage is carried out by conducting pre-survey observations to schools, asking permission to the school by submitting a research permit letter, compiling learning devices in the form of teaching modules, learning media that include teaching materials, instruments used during the data collection process that have previously been tested small and analyzed the results with ANATES to determine validity and reliability, making teaching preparations by compiling syntax flows and compiling learning plans with the GGE-JAS model. The GGE-JAS syntax includes exploration, team construction and discussion, presentation, QnA and Evaluation.

The implementation step includes dividing classes into control and treatment classes. The control class uses a learning model/method that is usually applied by teachers, so it is taught directly by the class teacher, while the experimental class with the GGE-JAS learning model is taught by the researcher. The research process begins with a pretest and ends with a posttest. Learning is carried out using the GGE-JAS model in MIPA 1 and MIPA 7 classes as experimental classes for five meetings in the mobility system material with each meeting allocated around 2x45 minutes which is adjusted to the learning plan based on the syntax that has been developed.

The evaluation step in this research is the process of collecting data with a post-test for critical thinking aspect, questionnaires for communication assessments, peer assessments and questionnaires for collaboration assessments while the assessment sheets that are assessed directly by researchers with the help of observers for students' creative thinking variables during the learning process include discussion activities and product presentations and distribution of questionnaires to students and teachers to assess the sustainability of teaching and learning activities on the mobility system material that has taken place. Data analysis was carried out by conducting prerequisite tests with the help of SPSS 25 statistical software.

RESULT AND DISCUSSION

Students' Critical Thinking Skills on Mobility System Material with the GGE-JAS Learning Model

Students' critical thinking skills were tested with pretest and posttest question instruments consisting of 25 multiple-choice questions with indicators included in each question item. Results shown in Table 1.

Table 1. Results of the analysis of students' critical thinking skills assessment on mobility system material with posttest

Postest Criteria	Class	
	Control	Experiment
Highest score	84	92
Lowest Score	52	40
Average	60.67	72
Student passed the standard	36	51
Student not passed the standard	12	21
Total students	36	72

The average value of N-Gain in the control class is 0.36 with a low category where only 44% of the class population reaches the medium category, this figure is considered low. The average N-Gain in the experimental class is 0.53 which is classified as medium, but the class population that managed to reach this medium category was 82%, this percentage is categorized as high.

After the mobility system material was taught to both control and experiment classes with the GGE-JAS model, this research showed students that passed the classical standard of the control and experimental classes was obtained respectively 33% and 71% of the class population. A model can be declared as an effective model if total students passed the classical standard reaches at least 70% of the class population. In the experimental class consisting of 72 students, the results were directly proportional to these requirements, so this learning model can be said to be effective. This is in accordance with the research of Putri & Mayasari (2023) which stated that GGE-JAS was able to improve student achievement. In general, this increase is influenced by the model used (Asman et al., 2022).

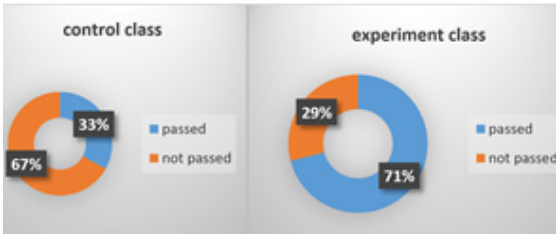

Figure 1. Comparison of Classical Completeness of Control and Experimental Classes of GGE-JAS Model on Mobility System Material at SMA N 1 Tengaran, Semarang Regency

From Fig.1 the comparison shows that there is a significant difference. Based on the results of the classical completion, the GGE-JAS learning model has been effectively applied to the experimental class because it has exceeded the minimum target of 70% of students successfully achieving classical standard of learning outcomes.

Achievement Level of Critical thinking Skills Indicator

The achievement of indicators also determines whether or not a skill variable can be achieved by students. In this research, the highest increase in students' critical thinking skills was in the indicator of students' ability to draw conclusions. This indicator requires students to understand data or case studies and be able to conclude information based on the question. Concluding in this case is the ability to describe and explain a problem in stages and systematically to produce a new meaning in the form of a conclusion. This indicator shows that the experimental class got a percentage of 95%, which means that students are good at drawing conclusions from discussions and observations (Banila et al., 2021).

This is according to Akbas (2021) who stated that students' critical thinking skills, which are effective in developing argumentation skills, allow students to evaluate the validity and strength of each component of the argumentation in the argumentation process. This is why critical thinking skills must always be trained in students by providing questions or observation sheets entitled data collection or case studies (Najoan & Makawawa, 2023). More detailed results percentages can be seen in Table 2.

Table 2. Achievement of Students' Critical Thinking Skills According to Indicators with the GGE-JAS Learning Model on Mobility System Material at SMA N 1 Tengaran, Semarang Regency

Critical Thinking Indicator	Correct Answers on Each Critical Thinking Indicator (%)	
	Control	Experiment
Interpret information	82.6%	87.8%
Logical arguments	25%	36.1%
Draw conclusions	87.8%	95.8%
Expressing facts	65.7%	82.6%
Re-check information	52.1%	68.5%
Explaining a condition	54.8%	65%
Average	61.4%	72.65%

Category	Quite capable	Capable

Table 2 shows that there is a significant difference in posttest answers between the control and experimental classes. The control class showed an average ability to answer critical thinking questions for the four indicators of 61.4%. While the experimental class had an average critical thinking question answering skill for the four indicators of 72.65%. The experimental class showed success in critical thinking skills because it showed that on average more than 70% of the class population was able to answer questions with the critical thinking indicators.

This research has successfully shown that the GGE-JAS learning model is able to improve students' critical thinking skills through syntax and teaching-learning activities in mobility systems so that the results show significant differences when compared to the control class and each critical thinking indicator can be achieved greatly so that the experimental class is in the able category of critical thinking skills. According to Tint and Nyunt (2015), the use of group learning models on critical thinking skills has a significant influence in facilitating students' critical thinking skills.

Achievement Level of Collaboration Skills Indicator

Measurement of the achievement of students' collaboration skills as one of the 4C components of the 21st century in this research was measured using a peer assessment instrument via a Google form filled out by peers from the same group based on their activity, working on interactive student worksheet and infographics in their discussion groups.

The data after from experimental class and control class were then analyzed descriptively quantitatively (%) to see whether or not there was an increase in collaboration skills in students, based on assessments from other group members presented in Table 3.

Table 3. Collaboration Skills of Each Indicator with GGE-JAS Learning Model for Mobility System Material at SMA N 1 Tengaran, Semarang Regency

Collaborative skill Indicator	Answers on Each Collaborative Indicator (%)	
	Control	Experiment
Positive interdependence	73.9%	90.1%
Individual accountability	73.8%	77.9%
Face-to-face interaction	69.44%	80.2%
Application of collaboration skills	52.43%	83.9%
Average	53.9%	83%
Category	Quite capable	Very capable

In Table 3, it can be seen that the control class and the experimental class have quite significant differences. Based on the Shapiro-Wilk normality test conducted, the percentage of achievement of the collaboration skills indicator, the result was 0.059(>0.05), so the data normally distributed. Then, to measure the homogeneity and significance of each control and experimental class data, there is a Levene's Test for Equality Variances value of 0.291 (> 0.05) so the data is homogeneous, and for significance it has a value of 0.035 (<0.05) data served is significantly different between the control and experimental classes. The comparison diagram can be seen below.

Figure 2. The Comparison of achievements level of collaboration skills between Control and Experimental Classes of GGE-JAS Model on Mobility System Material at SMA N 1 Tengaran, Semarang Regency

The average student in the control class had a total achievement of collaboration skills of 53.9%, which is quite capable, then in the experimental group consisting of class XI MIPA 1 and XI MIPA 7, the average achievement score was 83%, in very capable, this figure has met the criteria for students to be said to have collaboration skills.

From this research can be seen that the highest indicator is positive interdependence. This indicator explains that in a group in the class, each member in it is interdependent on the other members, so that the task can be carry on easily. The group forms cooperation in a solid positive climate by discussing openly both during the discussion of the work and the discussion to answer audience questions in front of the class (Mustabsyiah & Kusumaningtyas, 2019). The experimental class had higher results because the GGE-JAS learning implemented an open discussion system that allowed students to exchange ideas, share perspectives, and engage in critical thinking (Januardi et al., 2022). This is in line with (Cahyati, 2020) research that stated the group discussion method can improve problem-solving abilities and student learning achievement.

The lowest indicator in the experimental class is the indicator of individual responsibility interaction. This indicator emphasizes the ability where each member of the collaborative group has their own responsibilities in discussing, such as sharing materials or the opportunity to answer audience questions (Maulida et al., 2018). The experimental group is still categorized as capable in individual responsibility, but based on peer assessment, this indicator is classified as low because students in the experimental class are not very active when answering audience questions. The group members who answer are only dominated by a few students from all members, so that interaction with the audience and other presenter groups is considered less active.

Solution could be applied to divide the groups more heterogeneously and limit each group to answer audience questions so that each member has the same opportunity. Other collaboration indicators such as individual face-to-face interaction and the application of collaboration get achievement results that are not much different and are above 75% so that it can be stated that students are very skilled at collaborating with other friends.

This research shows that GGE-JAS model helps students to enhance their collaboration skill. Creating a classroom environment that facilitates collaboration between students is very important. This can be achieved by establishing collaborative norms, encouraging respectful communication, and providing opportunities for students to work together on various tasks. Teachers can model collaborative behavior and emphasize the value of teamwork in achieving common goals (Vonkova et al., 2022).

Achievement Level of Communication Skills Indicator

This research with the GGE-JAS model has proven successful in improving students' communication skills because it was found that the experimental class had an indicator achievement value of 74.8% while in the control class it was 59.4%. The difference in achievement results from the two classes was very prominent so that the achievement category in the experimental class was skilled at communicating while in the control class it was quite skilled at communicating. The difference in the models used is the main factor in this difference, this is in accordance with Hudoifiah's research (2018) which states that collaborative learning models such as the GGE-JAS model are able to improve students' communication skills. More detailed data can be seen through Table 4.

Table 4. Communication Skills of Each Indicator with GGE-JAS Learning Model for Mobility System Material at SMA N 1 Tengaran, Semarang Regency

Communication skill Indicator	Answers on Each Communication Indicator (%)	
	Control	Experiment
Ability to conduct discussions	66.67%	86.25%
Ability to present	79.16%	87.5%
listen to opinions from other students	62.5%	69.1%
convey opinions	50%	73.8%
Ability to ask questions	47.9%	75.52%
Ability to answer questions	50%	80.73%
Average	59.4%	74.8%
Category	Quite capable	Capable

The comparison results really shows that GGE-JAS model have a significant different results than class with conventional study method.

The comparison diagram shown in fig 3.

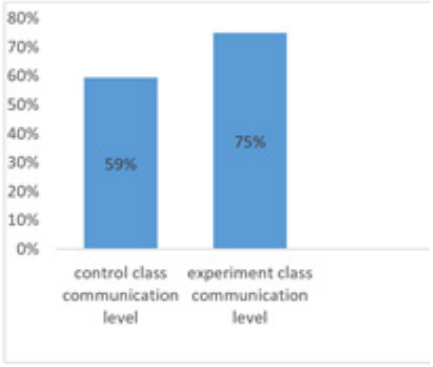

Figure 3. The Comparison of achievements level of communication skills between Control and Experimental Classes of GGE-JAS Model on Mobility System Material at SMA N 1 Tengaran, Semarang Regency

The highest indicator achieved in the control and experimental classes was being able to present the results of the discussion. Students are declared communicative in this indicator when they are able to convey the results of the discussion communicatively with language that is easy to understand, polite and clear. This indicator is a basic indicator of communication skills because students are required to present their results in front of an audience. The GGE-JAS learning model allows students to collaborate and communicate with their friends through different discussions and assignments. This helps students develop better communication and cooperation skills (Mayada, 2023). This is in line with Wati's research (2018) which shows that the application of the GGE model can improve students' communication skills. The results showed an increase in the average score of communication skills and continued to increase in the next cycle.

The lowest indicator in the experimental class was being able to express opinions. The discussion in the experimental class was quite intense because in this research, the GGE-JAS learning model has the syntax Team construction and discussion where this syntax the teacher as a facilitator encourages discussions in groups and students carry out discussions well and express the results of their discussions in a work and interactive worksheet which is then presented in front of the class to the audience. In this indicator, students in the experimental class got lower scores than other indicators but were still in the communicative category. This is because the group that came forward to present received many questions from the audience while students in the presentation group who answered questions were dominated by certain students. The solution to this problem is that students must be accustomed to working together and being responsible in groups. This can be a challenging because some students may not be used to working together and need time to adapt (Fajriana, 2022); (Krisnawati, 2012.

Other indicators in the communication variable, namely being able to conduct discussions, being able to listen to opinions from other students, being able to ask questions and being able to answer questions are at a skilled level because the percentage is above 60%. The achievement of these indicators is very different from the control class using conventional methods, so that the indicators in the experimental class with the GGE-JAS model are well facilitated, especially in the syntax of team construction and discussion and open discussion activities that have been stated in the study planner.

This research shows that the GGE-JAS model is able to encourage students and facilitate students to improve communication skills because the indicators in it are achieved well up to the category of communication skills. The syntax and learning activities contained in the study planner are proven to be able to facilitate students to stimulate communication because of the interaction patterns applied by teachers in the classroom.

Achievement Level of Creative Thinking Skills Indicator

Students' creative thinking skills only measured in experimental class with GGE-JAS model and are measured by an assessment sheet filled out by the observer and are the result of students' creativity by creating poster designs using the collaborative CANVA based on each topic. The control class did not carry out an assessment of the achievement of creative thinking skills because it used conventional methods and there was no syntax or activities in the study planner that facilitated students to think creatively.

In general, the results of the achievement of communication skills in experimental class I, namely class XI MIPA 1, obtained results of 74.03% and in experimental class II obtained results of 68.61%. The distribution of the achievement of creative thinking skills in the two experimental classes can be seen in Table 5.

Table 5. Creative Thinking Skills of Each Indicator with GGE-JAS Learning Model for Mobility System Material at SMA N 1 Tengaran, Semarang Regency

Collaborative skill Indicator	Answers on Each Creativity Indicator (%)	
	Experiment1	Experiment2
Fluency	80.56%	74.44%
Flexibility	60%	62.2%
Elaboration	62.2%	47.78%
Originality	93.3%	90%
Average	74.03%	68.61%
Category	Capable	Capable

This research shows that the experimental class with the GGE-JAS model successfully achieved the category of creative thinking skills because it was supported by various activities in the study planner based on the syntax that had been developed. This is in accordance with the research of Buchori & Cintang (2018) that active student learning activities will have a positive effect on students' creative thinking skills. Activities to stimulate students to think creatively are advanced activities in the team construction and discussion syntax because in addition to presenting the results of the discussion through interactive worksheet, students are also asked to create infographic through CANVA. The GGE model integrated with JAS makes it easier for students to use the resources around them, of course, has a significant effect on improving their creative thinking skills.

The highest indicator achievement in the experimental class is seen in the originality indicator because by checking through google lens assisted by observers, it was found that 90% of groups in the experimental class were original ideas and had never been made by anyone. While in other groups, in terms of design, there was no similarity to posters on the internet, but the explanation was too simple and was a paraphrase of the content on the internet web. This is in accordance with research by Wilatika & Yonata (2022) which states that originality encourages the development of unique perspectives among students. When students are encouraged to think out of the box and generate original ideas, they are more likely to approach problems from different angles.

The lowest indicator in creative thinking in experimental class 1 (XI MIPA 1) is seen in the flexibility indicator because it only reaches 60%. This flexibility aspect allows students to produce varied ideas, answers, or questions. Experimental class 1 found results in the creative thinking skills category but was still not optimal because based on data obtained from the assessment sheet, student members in the group had not fully proposed a variety of ideas, so that it can be seen from the graphic design on the poster which looks monotonous and the design theme used does not match the topic in several groups. The solution that can be done to overcome the problem of less than optimal flexibility in students is to build habits so that students are flexible by getting students used to group projects and collaborative assignments so that students adapt to different perspectives and work styles, and writing journals or group discussions about what works and what doesn't can help them understand the importance of adaptability in learning (Cox & Root, 2020).

Meanwhile, in experimental class 2 (XI MIPA 7), it can be seen in the elaboration indicator where students are required to be able to add or detail the details of an object, idea, or situation so that it becomes more interesting in its presentation. The achievement of this indicator is 47.78% in the category of being quite skilled at creative thinking. Elaboration is important in creative activities because through elaboration, students can refine and develop their initial ideas into more complex and nuanced concepts. The solution to overcome this is to do good brainstorming, especially on syntax exploration and provide constructive feedback that specifically targets elaboration. Encourage students to add more detail to their work, ask guiding questions that encourage them to think more deeply about their ideas (Kwangpukieo & Sawangboon, 2024).

The GGE-JAS model has facilitated students to develop creative thinking skills because students have been involved in group discussions or projects where they have to elaborate their ideas and build on their peers' contributions, this is stated in the syntax and study planner used. This collaborative environment promotes elaboration through dialogue and shared insights. This can be proven from the level of achievement of students' creative thinking skills in the category of creative thinking skills because it has a percentage above 65%. In line with the research of Mulya & Fauziah (2023) that in learning, students can produce more original solutions when they work together and support each other.

The Relationship between Each Aspect of 4C and its Pattern in the Experimental Class with the GGE-JAS Learning Model

The results of the relationship analysis on the 4C skill aspects were carried out using the

Structural Equation Model (SEM) using the Linear Structural Model (LISREL) version 8.8 from Joreskog & Sorbom through Second order confirmatory factor analysis (2nd Order CFA). The first level of analysis was carried out from the latent construct aspect to its indicators and the second analysis was carried out from the latent construct to its aspect construct (Latan, 2012).

Based on the results of the factor analysis, it was found that the model theoretically fits the empirical data (fit) but in the first stage analysis there were still indicators that did not meet the valid criteria of 0.3 (Linn. 1989). The results of the analysis can be seen in the path diagram display of the 4C (Standardized Solution) in figure 4. Critical thinking skill variables with 6 indicators symbolized by KRI1-KRI6, collaboration skills with 4 indicators symbolized by KOL1-KOL4, communication skills with 6 indicators symbolized by KOM1-KOM6 and creative thinking skills with 4 indicators symbolized by KRE1-KRE4.

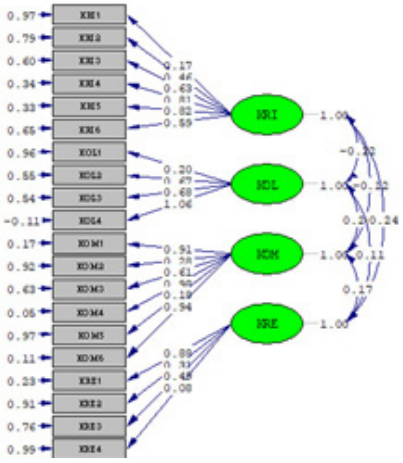

Figure 4. The Experimental Class Loading Factor Value in the First Stage Test on Each Variable is adjusted to the Indicators for Testing the Validity and Reliability of the Construct

Observing the information presented in Figure 4, based on Linn's statement (1989) which explains that the weakest factor load that can be accepted is 0.30. Thus, it appears that the valid loading factor is bigger than 0.3 for each indicator that builds each variable. Thus, there are 6 indicators that do not meet the valid criteria for measuring the variables. So it must be re-analyzed with the condition of removing invalid indicators (KRI1, KOL1, KOM2, KOM5, KRE2 and KRE4). Furthermore, it is re-analyzed and the results of the analysis can be seen in Figure 5.

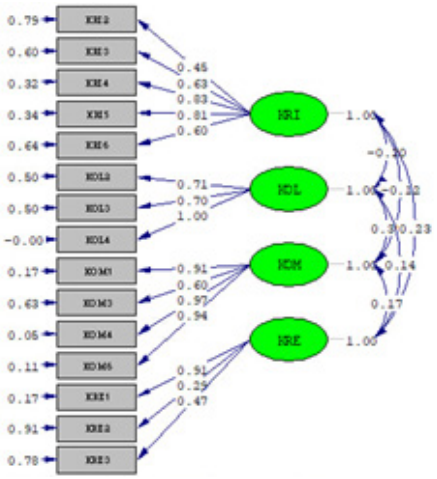

Figure 5. The repetition of the Experimental Class Loading Factor Values in the First Stage Test on Each Variable is adjusted to the Indicators for Testing Validity and Reliability of Construct

Next, the second stage analysis is carried out, the second level analysis involves the analysis of latent constructs to their aspect constructs. The aim is to test whether each indicator used theoretically to develop critical thinking skills instruments, collaboration skills, communication skills, and creative thinking are interrelated and truly supported by empirical data. Each aspect is an independent variable so that all four can be determined as X variables in this correlation analysis. Correlation testing begins with testing collaboration skills against the other three aspects, then continues with testing other skills. So it is necessary to conduct a correlation analysis that will reveal a pattern of relationships and a goodness of fit model. The results of the correlation analysis are presented in Figure 6 and Figure 7 and in accordance with empirical goodness of fit standards.

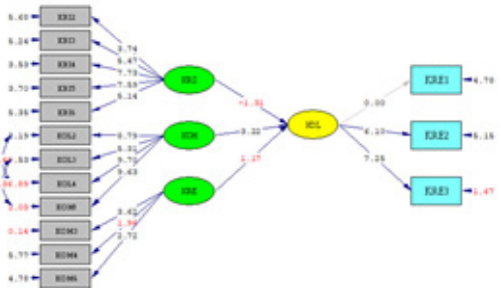

Figure 6. Correlation Pattern and T-values of Collaboration Skills towards Critical Thinking Skills, Communication Skills and Creative Thinking Skills of the Experimental Class with GGE-JAS Model on Mobility System Material

The results of the second stage analysis show that the t-values needed to test the significance of the loading factor value must be greater than the t-count of 1.99. Referring to the results of the t-values as in Figure 6, it appears that the correlation of students' 4C skills when viewed from the aspect of improving collaboration skills with the GGE-JAS learning model to the aspect of improving students' communication skills is significantly related because the t-values of 3.22 are greater than the t-count.

In the first correlation pattern of this research, it was found that the collaboration skills variable was significantly related to the communication variable. This results confirms the research of Thornhill-Miller, et al (2023) that among many other relationships, there is no collaboration without communication. This is because effective collaboration requires fundamentals in the form of strong communication skills. Students must articulate their ideas, listen to others, and provide constructive feedback in order to work together successfully (Shameel et al., 2023). This interaction fosters a deeper understanding of group dynamics and enhances the overall collaborative experience (Kamoun, 2019). In short, the relationship between collaboration and communication skills in students is fundamental to their development. When students engage in collaborative learning experiences, they simultaneously improve their communication skills, preparing them for future academic and professional environments where these skills are essential (Yu & Xe, 2023).

The collaboration variable is not significantly related to critical thinking skills because critical thinking skills can basically be trained by doing problem solving activities without having to form groups. This is also due to the different types of student learning styles, some students feel less able to concentrate when studying in groups and discussing because they tend to have individual learning styles (Biesenbach-Lucas, 2003).

The Collaboration variable does not have a significant relationship with creative thinking skills because in addition to different learning styles for each student, according to research by Fodness & Bell (2023) not all students have the same motivation to engage in discussions. If some students are not involved, a collaborative environment may not foster the creativity needed for effective problem solving. Effective collaboration requires balanced participation, and if this is lacking, creativity can decline due to the narrow scope of ideas explored (Amelia & Yosintha, 2022).

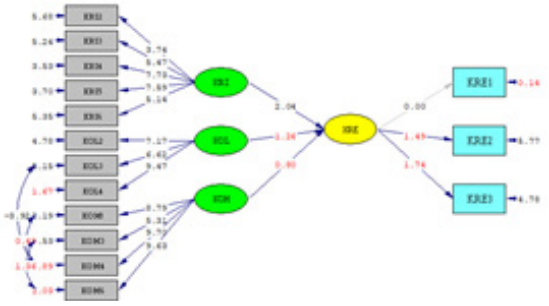

Figure 7. Correlation Pattern and T-values of Creative Thinking Skills towards Critical Thinking Skills, Collaboration Skills and Communication Skills of the Experimental Class with the GGE-JAS Model on Mobility System Material.

The correlation pattern shows that creative thinking skills variable was significantly positively related to the critical thinking variable. These results confirm the statements of several experts that one cannot be creative without critical thinking, for example, to generate alternative arguments (Paul and Elder in Thornhill-Miller et al., 2023). This is in accordance with Barbour's research (2016) that critical thinking helps generate a variety of ideas by encouraging the exploration of different perspectives and possibilities. Critical thinking encourages the creation of an environment that considers multiple points of view, resulting in more innovative solutions. Critical thinking allows the evaluation of ideas based on their feasibility, practicality, and potential impact. This ensures that creative ideas are not only new but also useful and applicable (Khan et al., 2023).

Creative thinking skills do not have a significant relationship with collaboration skills due to several factors including students who have not been trained in collaboration and creative thinking, students may not fully understand how to work together effectively, which causes inefficiency and reduced creativity, students have different levels of skills and experience, it can create unbalanced competition (Loudon, 2019; Haka et al., 2022; Putri et al., 2022).

Creative thinking skills do not have a significant relationship with communication skills. In accordance with the research of Smaliukien & Survilas (2018) that this negative relationship can be explained by the nature of team development. As previously known, problems in group communication are caused by the dominance of certain students.

CONCLUSION

The conclusion of this research is that GGE-JAS model is effective to improve students' 4C skills in the mobility system material for class XI MIPA SMA N 1 Tengaran, Semarang Regency and students' collaboration skills are significantly positively related to students' communication skills, while students' creative thinking skills have a significant positive relation with students' critical thinking skills.

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