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Cognitive Learning Outcomes: Its Relationship with Communication Skills and Collaboration Skills through Digital Mind Maps-Integrated PBL

Nurkhairo Hidayati, Siti Zubaidah, Endang Suarsini, and Henry Praherdhiono

Abstract—This study aimed to investigate the relation of communication skills and collaborative skills simultaneously on student cognitive learning outcomes using the Digital Mind Maps-Integrated PBL model. This correlational study was conducted on biology education students at Universitas Islam Riau, Indonesia. The research instrument consisted of observation sheets to assess communication and collaboration skills, as well as essay tests to measure cognitive learning outcomes. Data analysis used multiple regression analysis. The results showed a significant relationship between communication skills and collaboration skills on cognitive learning outcomes with F count (13.966) and p-value of $0.000 < \alpha (0.05)$. Besides, these two variables simultaneously also contributed to the achievement of student learning outcomes with an Effective Contribution (EC) value of 46.61%. Thus it can be concluded that the improvement of communication skills and collaboration skills have a contribution to the learning outcomes obtained by students. Therefore, educators can empower both of these skills so that students' cognitive learning outcomes also improve.

Index Terms—Communication, collaboration skill, cognitive learning outcomes, digital mind maps.

I. INTRODUCTION

Communication is an essential component needed by humans to adapt to the environment and is one of the crucial elements for establishing interpersonal relationships [1]. Communication can allow humans to express concepts and ideas in their minds. Besides, communication can also influence others so that success can be achieved through good communication [2]. The effective use of communication skills is an important interpersonal competency so that it becomes one of the skills needed in the 21st century [3]. Interpersonal competence involves developing communication skills. Not everyone has good communication skills, so the important role of these communication skills needs to be empowered and trained [4]. Empowerment of these skills can be carried out in various fields including education because effective communication skills play an important role in building student character [5]

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and preparing students for various job opportunities [6].

Communication skill are the ability to interact with verbal and non-verbal messages by listening and reacting efficiently [7], [8], involving the delivery of ideas, messages, and information to influence someone's behavior or persuade them [9]. Communication skills can also be interpreted as the process of delivering information and using listening skills effectively and showing openness to the ideas and thoughts of others [10]. Communication skills require the ability to understand what others are saying and be aware of the source of communication [11]. Effective communication is influenced by various elements that must work together in harmony. These elements include the sender of the message, the recipient or listener, the message, the media, feedback, and the purpose of communication [12], [13] so as not to cause differences in perception and hinder the success of communication [8]. Communication includes four primary skills, namely speaking, listening, investigating, and observing [6].

Students who have good communication skills can achieve better learning outcomes [14]. This connection occurs because someone with good communication skills has adequate knowledge of the information to be conveyed and can receive information well. Mastering this information ultimately helps achieve better learning outcomes [15]. In addition, communication is a vital component to motivate students who in turn can help them take action and achieve the goals set at the beginning of learning [10]. Communication skills can help convey messages in clearer and better easier to understand ways so students can understand the material being studied. Understanding of this material contributes to the achievement of cognitive learning outcomes [16]. Even Fashiku [12] explains that a lack of readiness for learning does not cause the academic failure of students, but because the communication that takes place is not effective.

Communication skills are closely related to other skills, for example, collaboration skills [8]. When collaboration occurs between people, communication skills are needed for the collaboration to take place. In other words, communication skills become the basis for collaboration skills. During collaborative activities, communication has the role of bringing implicit thinking towards explicit explanation [17]. Communication and collaboration are about fostering effective communication and engaging with others in group relationships [18].

Collaborative skills are the ability to work in teams by joining several individuals together to achieve common goals

¹ [19], [20] by supporting the work of other team members [21]. In collaboration, there is interaction among group members. Members of this group consist of individuals with different characteristics so that they can share their experiences and information [22], [23]. Several ways have been proven effective in teaching the principles of collaboration in the classroom, including constructing knowledge, establishing group agreements, determining the stages of division of work and accountability for tasks [24].

Various important roles of collaboration skills can be found not only during the learning process but also when students are in a work environment. Van Laar, Van Deursen, van Dijk, & de Haan [3] in their writings explained that collaboration skills are an important part of 21st-century skills, especially for workers because collaboration skills require teamwork. Teamwork plays a role in team integration so that each team member can share ideas and knowledge into learning experiences [23], [25]. Another benefit of collaboration skills is improving students' social competence and learning effectiveness [26] to produce better performance [27].

Cognitive learning outcomes can be linked to collaboration skills. During the collaboration, there is social interaction among students in the group. It stimulates the elaboration of conceptual knowledge because in groups, of students try to make themselves understood and able to understand other group members [24] so that construction of shared knowledge [18]. The research found that active participation of students during collaboration in groups can help them complete the tasks better than individual work [28]. Other research also explains that students who work collaboratively can express ideas better [29] and improve learning outcomes [30]. Conversely, the lack of collaboration skills hinders the performance of students in groups so that it influences learning outcomes [31].

The relationship between collaboration skills and cognitive learning outcomes has been done as described in the previous paragraph [15], [18], [31]. Likewise, the relationship between communication skills and cognitive learning outcomes has also been widely explained in various study [10], [14], [15]. However, studies that examine the relationship between the two skills together on cognitive learning outcomes so far are still rarely conducted. To find out the relationship between communication skills and collaboration skills, these two skills need to be empowered in the classroom by using appropriate learning strategies.

The development of communication skills and collaboration skills is a long-term effort, but educational institutions such as university can take a role through implementing active learning processes. The active learning process involves students in each stage of learning so that the learning experience takes precedence [32]. This learning experience is obtained through students' activities in searching for information, discussing up to making decisions and conclusions [33] so that they can practice communication and collaboration skills.

Various learning strategies facilitating communication and collaboration skills in the classroom have been suggested in the field of education [34]. For example, research conducted by Martyn, Terwijn, Kek, & Huijser [35] that Problem Based

Learning (PBL) helps students explore information to improve communication and collaboration skills. PBL also directs students to work collaboratively to find solutions [36]. Other studies using mind map-oriented sharing approaches enable students to learn to collaborate. Mind maps that are made digitally or known as Digital Mind Maps (DMM) can be shared among friends [37] and develop various lifelong skills including communication skills, teamwork, critical analysis, and planning work [38]. The use of mind maps also helps in preparing presentations so that the information to be communicated becomes easier to understand [39]. Therefore in this study, DMM is integrated with PBL, which is then abbreviated to DMM-Integrated PBL model.

The integration of DMM and PBL was done because in PBL students are presented with tasks in the form of problems. When students are presented with assignments in the form of problems, they rarely try to do the right brainstorming of the problem before trying to solve the problem [40]. This activation of prior knowledge helps students by simulating the links between new and old information. Integration PBL with mind maps in this study because mind maps can act as a mediator in connecting between one concept and another, visualizing prior knowledge in the form of broad concepts and add new detailed information [41], and assist in summarizing PBL discussions and enabling reflection [42].

Referring to the explanation in this introduction, a study is needed to reveal the relationship between communication and collaboration skills on cognitive learning outcomes using the DMM-Integrated PBL learning model. The potential possessed by this learning model can improve communication and collaboration skills. Through these multiple correlation studies, the contribution of each variable can be expressed in cognitive learning outcomes. Even the simultaneous contribution of the two variables can also be seen in cognitive learning outcomes.

II. METHODS

A. Research Design

The research done multiple correlational study to reveal the contribution of communication skills and collaboration skills to the cognitive learning outcomes of students by using the DMM-Integrated PBL model. The learning process began with the activities of students preparing DMM. Making DMM can help students connect the material learned with the concepts they have learned before. In the classroom, before orienting students to the problem, the lecturer asked questions related to the DMM that students had made. After students made a problem statement, the next step is to search for references to answer the problem. The result of search references are written in reports and communicated through class presentations and discussions. Responses from various groups could enrich the solution to the problems that had been found. In the final section, evaluation and reflection was carried out on the learning process that has been carried out.

B. Instrument

The instrument for measuring communication and

collaboration skills was observation sheets. This assessment rubric used a Likert scale with four answer choices which are very good, good, enough, and not good. The measured communication aspects were speaking, writing, listening, and nonverbal. The collaboration aspect consists of responsibility, respect, contribution, organize work, and work as a whole team. The instrument for measuring cognitive learning outcomes in an essay test based on bloom taxonomy. Before being used in data collection, all instruments were validated. The results of expert validation showed the validation value of communication and collaboration instruments were 3.83 (valid). The validation test of the cognitive learning achievement test results using the Pearson product moment test showed that all items in the instrument were valid and the reliability test results were 0.872 (reliable).

C. Data Collection and Analysis

Data collection of communication skills and collaboration skills was done by doing the observation during the learning process. Observations made are based on the assessment rubric provided. Observer scores according to the activities of students. Learning outcomes data were collected through essay tests given to students. Furthermore, a score was given for each answer to the questions that had been done by students. All research data were first tested for normality using KolmogorovSmirnov. The results of this normality test showed a pvalue of $0.200 > \alpha$ which means that the research data was normally distributed. Furthermore, the research data were analyzed using multiple regression analysis to test the correlation of predictors and criteria.

III. RESULTS AND FINDINGS

This study used communication skills and collaboration skills as predictors to determine their relationship with cognitive learning outcomes as criteria. The initial step of the researchers used the Anova test. ANOVA test aimed at determining determine whether the predictor significantly has a relationship with the criteria or not. ANOVA test results can be seen in Table I.

TABLE I: THE ANOVA OF THE CORRELATION BETWEEN COMMUNICATION AND COLLABORATION SKILLS ON COGNITIVE LEARNING OUTCOME WITHIN DMM-INTEGRATED PBL

Model	Sum of Square	d	Mean Square	F	Sig
1 Regresion	2345.4	2	1172.710	13.966	.000 ^b
Residual	2686.9	3	89.966		
Total	5032.3	3			

- a. Dependent Variable : Learning Outcome Cognitive
- b. Predictors: (Constant), collaboration, communication

Table I showed the calculated F value obtained was 13.966 with a p-value of $0.000 < \alpha (0.05)$. This number gives the meaning that communication skills, together with collaboration skills, can significantly predict student cognitive learning outcomes.

After seeing the ANOVA test results, it is continued by knowing the coefficient of multiple correlation as shown in Table II. Table II summarizes the results related to the presence or absence of the relationship of all predictors with criteria. The regression equation obtained is $Y = -11.671 + 0.341X_1 + 0.471X_2$.

TABLE II: THE REGRESSION COEFFICIENT OF THE CORRELATION BETWEEN COMMUNICATION AND COLLABORATION ON COGNITIVE LEARNING OUTCOMES WITHIN THE DMM-INTEGRATED PBL

Model Summary				
Model	R	R square	Adjusted R Square	St Err of the Estim
1	.683 ^a	.466	.433	9.16330

Predictors: (Constant), collaboration, communication
Dependent Variable : Learning Outcome Cognitive

Referring to Table II, the value of R obtained was 0.683, while R2 was 0.466. Thus this table provides information that communication skills and collaboration skills together contribute 46.61% in achieving cognitive learning outcomes of students, while the remaining 53.4% is explained by other variables outside this study. The contribution of each predictor variable to the criterion variable can be seen in Table III.

TABLE III: CONTRIBUTION OF COMMUNICATION AND COLLABORATION SCORES ON COGNITIVE LEARNING OUTCOMES

Variable	EC	RC
Communication Skill	17.67%	37.90%
Collaboration Skill	28.94%	62.10%
Communication & Collaboration	46.61%	100.00%

Table III provides information that collaboration skills make a greater contribution than communication skills in determining the achievement of students' cognitive learning outcomes. The contribution of collaboration skills to cognitive learning outcomes is 62.10% while communication skills contribute to 37.90.

IV. DISCUSSION

Communication skills and collaboration skills can be used to predict the achievement of students' cognitive learning outcomes. The results of this study indicate these two variables contributed 46.6% to cognitive learning outcomes. Communication and collaboration skills are important skills needed by students in their social environment. Both of these skills during the learning process are empowered through the DMM-Integrated PBL learning model. The implementation of the DMM-Integrated PBL Model places students in group learning situations and has discussions to solve problems and utilize DMM. The results of research by Liyaghatdar, Abedi, Jafari, Bahrami [43] found that the learning process carried out with discussion was more effective in improving communication skills and learning outcomes. Furthermore, this learning model also helps students in constructing knowledge. Various concepts and knowledge that were read

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when compiling the DMM were shared with other members through discussions. In particular, if group members find different information or ideas, there are more opportunities for discussion. Exposure to different points of view results in increased knowledge, thereby increasing learning outcomes [44].

Previous research done proves that there is a correlation between communication skills and student learning outcomes because communication skills are inseparable from the understanding and level of knowledge of the transmitter and receiver of information. In other words, the better a person's communication skills are, the better their knowledge and the learning outcomes achieved will also be better [14]. In addition, when conducting discussions to solve problems, students try to understand the information better communicated by their peers. For example, by summarizing, examining, and trying to imagine perspectives from points of view that conflict with their points of view so that the right conclusions are reached [34].

Communication skills bring the learning situation to a better understanding because communication skills are related to the ability to transfer information and negotiate to mean. When students want to convey information, they must ensure that the information can be well received by the listener. Therefore, the readiness of students in communication is also determined by the level of understanding of the content or learning material. One of the criteria for someone with good communication skills is to show a comprehensive understanding of the topic presented [45]. The importance of mastering content is also explained by Staniforth [46] that mastering content at the time of communication affects the interaction between the transmitter and receiver of the message.

In addition to communication skills, collaboration skills also correlate with the achievement of cognitive learning outcomes. Even the results of the analysis show the contribution of collaboration skills is more significant than communication skills on student cognitive learning outcomes. The contribution of collaboration skills to the achievement of learning outcomes because collaboration activities enable students to be actively involved in the learning process, especially in problem solving. During the collaboration, students are responsible for completing assignments and various knowledge they have. This is in line with research conducted by Brindley, Walti, & Blaschke that at the time of collaboration, students share their knowledge so that they obtain richer knowledge through joint exploration and the achievement of shared meanings [47]. Other research results also show that collaborative activities make students more involved in the learning process so that it leads to increased mastery of concepts [48], [49].

Collaboration allows groups to make better decisions than each individual does its possibility to consider various perspectives. In the educational environment, many studies have been directed at collaboration. This research mainly focuses on the use of collaboration to optimize learning outcomes [50]-[52]. Collaboration in groups provides an opportunity to work constructively with peers and enrich knowledge and understanding by explaining concepts to others so that learning outcomes are also better [53]. In

addition, during collaboration, there is an interaction between peers. This interaction encourages cognitive conflict by uncovering differences in knowledge between one another, thereby increasing students' understanding of a concept. An important aspect of collaborative activity is the negotiation of conflicting points of view [54].

The contribution of collaboration skills to learning outcomes is inseparable from the learning model used. As in this study, using the DMM-Integrated PBL model facilitates students working in groups. Various benefits are obtained when students work in groups. For example, they support each other when experiencing problems, share information, and find solutions together. In groups, students need to solve problems, deal positively with conflicts that might arise, and reach an agreement [18]. Besides, the DMM-Integrated PBL model also provides students the opportunity to reflect on the final stages of learning. This reflection is one process to improve collaboration skills as it can equate different perceptions through respecting the opinions of others [55].

To end the explanation in this section, we exclaimed that the achievement of students' cognitive learning outcomes can be done not only by using learning models focusing on final results but can also using learning models that improve communication skills and collaboration skills. It occurs because both skills have been proven to have the contribution to cognitive learning outcomes simultaneously. Students with good communication and collaboration skills are expected to have more significant opportunities to actualize themselves in various fields.

V. CONCLUSION

Based on the results of the study, it can be concluded that there is a significant relationship between students' communication skills and collaboration skills with cognitive learning outcomes of students using the DMM- Integrated PBL model. It occurs because communication skills and collaboration skills contribute to the achievement of cognitive learning outcomes simultaneously. However further exploration indicates that collaboration skills contribute more on cognitive learning outcomes than communication skills. The findings of this study are expected to provide direction for further research to utilize the variable communication skills and collaboration skills as predictors for other criteria besides cognitive learning outcomes.

CONFLICT OF INTEREST

We certify that there is no actual or potential conflict of interest in relation to this article.

AUTHOR CONTRIBUTIONS

Hidayati formulates of overarching research goals and aims, development or design of methodology, presentation of the published work. Zubaidah plays a role in oversight and leadership responsibility for the research activity and commentary manuscript. Suarsini contributed specifically critical review, commentary manuscript and verification. Praherdhiono participate in revising manuscript critically for important intellectual content.

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