



Exploring Students' Perspective on Using Online Collaborative Platform in Biology Laboratory Work

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abstract

The COVID-19 pandemic has changed the teaching and learning methods. Learning activities that were originally done face-to-face must be adjusted to online learning. This change also occurs in laboratory activities. As students must adapt to the different method of learning, their behavior in learning is affected, as well, including how they collaborate in laboratory work that is conducted online. This study aims to explore students' perspective on online collaborative learning tool in biology laboratory work. The online collaborative learning process is supported by a collaboration platform called Trello. Survey was conducted by collecting responses from students in Department of Biology Education who participated in the genetics laboratory work. This study was conducted using survey, which was conducted after students had participated in laboratory work for two weeks online using the virtual collaborative platform. The questionnaires measured students' perspectives on using Trello for collaborating with their team during laboratory work. The instrument also measured students' perception on how Trello supported their collaborative learning online including effective group teamwork, discussion activities, and communication within group such as asking questions, answering questions, and making arguments. A number of 127 valid responses were analyzed descriptively. The result showed that students agreed that Trello was easy to use (97%) and supported them to conduct group work easily (98%) and discussion more effectively (87%). Result from this study provides positive evidence on how Trello supports students' collaboration during laboratory work.

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1. Introduction

The occurrence of a pandemic in early 2020 in Indonesia has caused changes in various aspects of life, one of which is in the field of education. Schools that were originally conducted offline or by face-to-face learning are forced to adjust to distance learning. As a result, the implementation of teaching and learning must adapt by using technology such as Learning Management System, video conference platforms such as Google Meet, Zoom Cloud Meeting, and Cisco Webex, and a free or open source tool for collaborative learning such as Trello which adapts the Scrum

methodology for teaching and learning purposes (Naik et al., 2020). Teachers also begin to combine virtual synchronous activities and asynchronous activities by utilizing online media (Limiansi et al., 2020). This change also affects biology learning. Learning, which should be carried out by involving laboratory work directly by observing the object, has been replaced with online laboratory work. This change also occurs not only at the high school level but also in higher education. Due to the limitation of activities, direct lecture activities have been replaced with distance learning, including the implementation of laboratory work.

Implementation of online laboratory work is a challenge for universities, especially for the science study programs. The implementation of the laboratory work which must present the original object of observation and the implementation of activities in the laboratory must be replaced with independent laboratory work activities by each student. For lecturers, online laboratory work becomes a challenge as they must design a laboratory work that can at least represent activities in the laboratory with remote independent activities. Lecturers also need to think about alternative tools and materials that can be used by students to replace the tools and materials available in the laboratory or alternative teaching methods such as by combining research laboratory and the virtual one (Hurtado-Bermúdez & Romero-Abrio, 2020). Meanwhile, students are required to be able to communicate, discuss, and collaborate separately. Although students can conduct the experiment remotely through, for instance, a virtual lab, the challenge remains. Evaluating students' collaboration and progress is still a difficult task (Elmoazen et al., 2023). Therefore, there is a need for adjustments by both lecturers and students to carry out collaborative learning online (Alam & Mohanty, 2023).

Online collaborative learning emphasizes on the collaborative activities and knowledge building which are mediated by the internet. It means that learners work together online to discuss issues, and apply new knowledge, analytical terms, and tools to solve problems, construct plans or develop explanation for a phenomenon. These activities lead to conceptual understanding and knowledge product. Online collaborative learning is based on peer discourse which is conducted by text-based discourse and asynchronously using web discussion forums or online conferencing systems. There are three key phases of knowledge construction through discussion in online collaborative learning, including brainstorming activities in a group (idea generating), comparing, analyzing, and categorizing (idea organizing), and constructing artifacts (intellectual convergence) (Harasim, 2017). Online collaborative learning has a close meaning to virtual collaborative learning (VCL). VCL has several characteristics. It builds teamwork in small groups, emphasizes on information technology to facilitate direct interaction of students in virtual environment, and emphasizes on the learning instructions and the teachers. Teachers should design a very detailed and systematic learning experience and ensure their presence during the learning process as a guidance for students (Weber et al., 2008).

Online collaborative learning can take the form of discussion among the whole class or team activities within smaller group (Faja, 2013a). Online collaborative learning has various forms, including online discourse, group learning, instructor-led, asynchronous, place-independent, text-based, and internet-mediated discourse. However, teachers must be prepared well prior to the activities. In conducting online collaborative learning, at least 10 aspects must be fulfilled, including appropriate technology, clear guidelines for student online behaviour, student orientation and preparation, clear goals, choice of appropriate topics, setting an appropriate requirements for discussion, defining learning roles and expectation, monitoring students participation, instructor presence, and ensuring a strong articulation between discussion topics and assessments (Harasim, 2017).

Online collaborative learning has been used widely in various subjects. For example, in English classes, students have a valuable academic experience of using their knowledge, solving problems,

and developing teamwork skills using collaboration software (Bakir et al., 2020). Virtual digital boards are also used by students of natural science and mathematical specialties (Bodnenko et al., 2020). In the information system management course, students give positive feedback to collaborative activities and peer interaction during courses (Faja, 2013b).

Other e-learning platforms, such as Edmodo, have been used to assist students in learning biology. In a previous study, learning biology was conducted using the e-learning platform Edmodo. The research developed an e-module based on Edmodo mobile (Android-based) which students could easily access on their smartphones. This e-module was designed to increase the students' conceptual understanding in cell biology. The study employed the R&D design using the 4D model by Thiagarajan, involving define, design, and develop. The e-module was validated by content experts, media experts, and teachers as practitioners using questionnaires. The feasibility of the e-module was also tested using questionnaires on 24 students. The result showed that the Edmodo e-module on cell biology developed through Thiagarajan's 4D has valid criteria. Thus, it can be used in cell biology learning (Hidayati et al., 2019).

Other studies have been conducted in the midst of the pandemic. Research was conducted on the use of online learning media in the form of Edmodo application. It examined the effect of using online learning media in the form of WhatsApp assisted by Edmodo in improving learning outcomes in relation to students' learning motivation. The experimental technique used was the 2x2 factorial design. The result showed that the use of WhatsApp assisted by Edmodo for online learning has a significant effect on learning outcomes, especially among students with high learning motivation (Putri et al., 2021). Another study was conducted to improve the quality of learning using the Edmodo application in learning biodiversity for Grade 10 senior high school students. The research was also conducted during the Covid-19 period. The method used was classroom action research consisting of four stages including planning, action, observation, and reflection. Data collection techniques included questionnaires, observations, and documentation. The instruments were online questionnaires on learning interest and online observation sheets. The result showed that the application of Edmodo in online learning increases students' interest in biodiversity and learning. The use of Edmodo can be applied to teach students on how to learn on their own, actively look up information prior to learning, hold online discussions about given assignments, and complete assignments on time (Wicaksana et al., 2020).

Furthermore, a previous study also had used Trello as virtual learning environment (VLE) and active learning organizer for project-based learning. In the research, Trello was used in active learning approach involving multidisciplinary studies such as project-based learning (Fernando et al., 2019a). Students were supported by a tutor in a team for each area to identify group assignments. From the first to the last activity, Trello as a VLE was disruptively essential for project organization as well as their project's success. The result of the study showed that Trello as an innovative virtual learning environment and PBL organizer seems to have a positive impact based on the author's/tutor's perception on the students' feedback and project results. Although research on using various e-learning platforms for biology learning has been conducted, data on students' perspective on collaborative learning online using Trello as a virtual learning environment in science education especially in biology education is limited.

Another study found that students dislike online group work more than face-to-face learning. There are seven most common problems found among students. First, students do not understand the benefit of group work. Second, students are unable to select the appropriate process and size of the group. Third, students lack social skills, such as collaboration skills, management skills, and leadership skills, that are very much needed to be an effective member of the group. Fourth, some students are free riders who do not take part on group discussion yet receive the same grade. Fifth, there is an inequality of students' abilities and skills within the group. Sixth, some students find

that their groups have poor distribution or delegation of roles and responsibilities that causes a withdrawal of the group member. The last problem is the equitability of individual assessment within the group (Roberts et al., 2007). Therefore, instructors need the help of technology to overcome these problems.

One application that can be used to enhance the collaboration in laboratory activities is Trello. Trello is one of the work management applications designed to track team project. Trello was inspired by the Kanban method based on a visual system for work management. Trello also enables users to design a project, including setting the project's deadline, making notes on projects and tasks, and assigning tasks with collaborators. The features of Trello include creating a board to manage project, inviting members to collaborate, adding lists for collaboration work, as well as creating and managing tasks. Technology used in the course should be transparent. It also should be user friendly and easy to operate as if students were taking face-to-face class (Lehman & O Conceição, 2010). Trello can be used as collaborative asynchronous learning. It provides students with opportunities to collaborate with other students at anytime and anywhere. Online problem-solving, cooperative learning through online assignments, and online discussion are all examples of collaborative asynchronous activities. For the collaborative asynchronous activities in Trello, teachers can also provide teaching materials in the board. For this reason, Trello has become one of the most popular digital boards used in organizing students' cooperative learning and promoting the sharing of knowledge and experiences (Bodnenko et al., 2020; Fernando et al., 2019a).

Compared to other virtual digital boards, Trello has many functions, such as (1) collaboration in one board, (2) placing texts, illustrations, and videos on the desktop, (3) building documents, widgets, and HTML codes, (4) common browsing of websites online, (5) consistency with other web-services, (6) collaboration for both registered and unregistered participants, and (7) free registration and use. As for the academic field, Trello can serve as an alternative learning environment. It allows collaborative and interactive work, and promotes the sharing of knowledge and experiences (Fernando et al., 2019b). In order to enhance the quality of learning especially in laboratory work during the distance learning, the virtual collaborative platform has been used to power up students' activities. However, in laboratory works, this type of learning activities has not been applied yet. Therefore, data about students' perspective in using Trello need to be explored before implementing online collaborative learning extensively. The findings of this study provide recommendation to implement collaborative tools such as Trello in other laboratory works to enhance students' work.

2. Method

This study was conducted using survey to gather information at a specific period to describe the nature of the conditions that are present (Cohen et al., 2007). The survey was conducted after students had participated in laboratory work for two weeks online using the virtual collaborative platform Trello. The participants of the study were 127 undergraduate students at Department of Biology Education, Yogyakarta State University. The participants were divided into two different study programs, namely the Biology study program and Biology Education study program. A total of 60 participants were from the Biology study program (47.24%) and 67 participants were from the Biology Education study program (52.76%). Based on gender, 111 participants were female students (87.4%) and 16 participants were male students (12.6%).

The questionnaire used in the survey consisted of 11 questions using the Gutmann scale. The questionnaire measured students' perspectives in using Trello to collaborate with their team during laboratory work. The instrument also measured students' perception on how Trello supported their collaborative learning online including effective group teamwork, discussion activities, and

communication within group such as asking questions, answering questions, and making arguments.

Prior to the study, the content of the instrument was reviewed by experts. The validity of the questionnaire was also estimated using Pearson's correlation. The result showed that all of the questions were valid with p values less than 0.05 (p Q1=0.000, p Q2=0.007), p Q3=0.002, p Q4=0.000, p Q5=0.000, p Q6=0.000, p Q7=0.000, p Q8=0.000, p=Q9=0.000, p Q10=0.000, p Q11=0.000). The consistency of the instrument was estimated by Guttman Split-Half Coefficient with the value of 0.802, indicating that the instrument was reliable.

3. Result and Discussion

The research was conducted in the genetics laboratory work class which was held fully online for two weeks. The synchronized meeting was conducted through the video conference application Google Meet. Prior to the laboratory work, students were introduced to the collaborative application Trello by giving them a brief explanation of its general features. The topic used in this research was the phenotypic diversity in humans. The purpose of this laboratory work was to understand the diversity in humans based on the observation of phenotype characteristics. In this laboratory work, students were divided into small groups of four to five students. Before starting the laboratory work activity, every student in the team joined the Trello via the link that had been provided by the instructor. After all the students became part of the virtual board, students started the laboratory work by following the activity that had been designed in virtual board of Trello. Figure 1 below depicts the Trello virtual board used during the genetics laboratory work.



Figure 1. Virtual Board for Genetics Laboratory Work

There were several activities carried out using Trello. The first activity was determining the characteristics of human phenotypes which could be observed in their classmates. Six human traits were observed in this activity. Those characteristics were hair type (straight hair or curly hair), hair swirl (clockwise or counter-clockwise), dimple, earlobe (free earlobe or attached earlobe), tongue curling, and blood types (A, B, AB, or O). Those traits were listed in the first activity in Trello virtual board. The following activity was determining the characteristics of each student by using a genetic wheel. The observed traits were written inside the genetic wheel starting from the inner band to the outer band of the wheels. After that, students observed their traits starting from the

inner band and identified the appropriate trait which described their own characteristics. Students were instructed to move outward of the wheel to find their characteristics for other traits until they reached the blood types in band six. Following this step, students recorded the number in the outer part of the wheels that indicated the genetic diversity index. The number was then recorded in the virtual board including the traits of each student. The genetic diversity index and the students traits would be discussed within the group to determine the phenotypic diversity in the class.

During laboratory work activities, students also conducted discussions on the Trello virtual board. In the discussion forum, each student was able to write opinions and ask questions about the specific topic on the Trello virtual board. Moreover, on the same board, students were able to write their responses and give comments of the previous post. Students also could provide pictures to explain certain things. The last activity in the virtual board was submitting the laboratory report. Students could submit their report on the board or provide the link to the document. In this case, the instructor also had provided lists that explained the progress in writing laboratory report. Therefore, all laboratory work progress was recorded fully in the Trello virtual board. At the end of the laboratory activities, students were asked to complete the online questionnaires.

Based on the questionnaires, 104 students (81.89%) had used various applications to collaborate online, while 23 students (18.11%) stated that they had never used any application to collaborate online. The applications they had used to collaborate are WhatsApp, Google Meet, Google Classroom, Zoom, Quizizz, Webex, Google Doc, Padlet, Learning Management System, Google Drive, Mentimeter, Figma, Miro, Edmodo, Discord, Google Slides, Google Workspace, Telegram, Kaskus, Twitter, Edlink, Concept Board, and Google Jamboard. Based on the answers, Trello as a form of virtual collaborative tool was a new thing for students. Of the total participants, only 8 students (6.3%) had used Trello, while 119 students (93.7%) had never used Trello before.

During the pandemic, various online platforms were used for learning. The platforms used were Google Meet, Google Classroom, WhatsApp and other video conference applications such as Zoom Meeting (Handayani* & Jumadi, 2021; Haryati et al., 2021; Khaleyla et al., 2021; Permana et al., 2021; Tauhidah et al., 2021). Various learning platforms were also used in learning biology for synchronous learning activities, asynchronous learning activities, or the combination of both. Blended online learning is the combination of asynchronous and online-based virtual synchronous activities. For instance, WhatsApp, a communication platform not intended for online learning, is the medium that is utilized the most frequently in both synchronous and asynchronous activities. By using this combination method, teachers and students can communicate effectively. Even though students have a number of learning limitations, balanced synchronous and asynchronous activities will help them achieve the best possible learning experience (Limiansi et al., 2020).

According to the students' response regarding the convenience of using the Trello platform, 123 students (97%) stated that Trello was easy to use because Trello made it easy for them to participate in online genetics laboratory work. However, 4 students (3%) said otherwise. In addition, 121 students (95%) stated that Trello allowed them to do genetics laboratory work, while the 6 other students (5%) did not feel the same way. Compared to other types of digital virtual boards, Trello has various opportunities. Trello can be used to collaborate on one board. It can reduce communication difficulties among students and tutors. It also facilitates discussion when organizing cooperative learning such as project activities in distance learning. This platform also provides features to place texts, illustrations, videos on the desktop. It also can build documents, widgets, and HTML codes. Ultimately, it will facilitate the exchange of information among students. It also provides better visualization of training information when organizing lectures or

classes. Additionally, Trello is compatible with other web services (a posting board for your website, blog, or social networking page, creating a board specific QR code). It is able to enhance education's communication component and spread the work to other Internet users. It also aids in the evaluation of produced materials by organizing cooperative education or project activities. Moreover, Trello allows users to collaborate with both registered and unregistered participants in the board. The process of signing up for the resource is made easier, but any board posts or comments will be added anonymously (Bodnenko et al., 2020).

Trello provides various features that help students collaborate within the small group and the bigger group. In this study, students' collaboration using Trello can be seen from three aspects, namely effective group teamwork, discussion activities, and communication within group including asking questions, answering questions, and making arguments. Students' responses regarding collaboration using Trello can be seen in the following Figure.

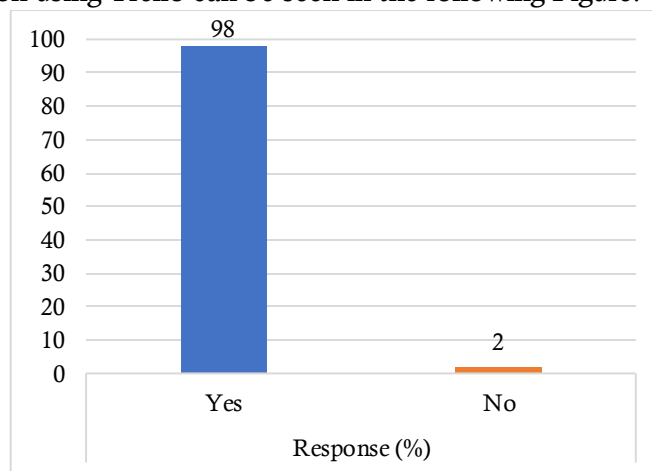


Figure 2. Teamwork

Figure 2 illustrates that 98% of students agree that they can do group teamwork using Trello. A vast majority of the students positively perceive Trello in helping them work within the team. Trello allows them to organize their work more effectively, arrange their activities based on the laboratory work procedures chronologically, as well as prioritize task that should be done immediately. In the platform, students can also highlight certain activities to make them more noticeable by other teammates.

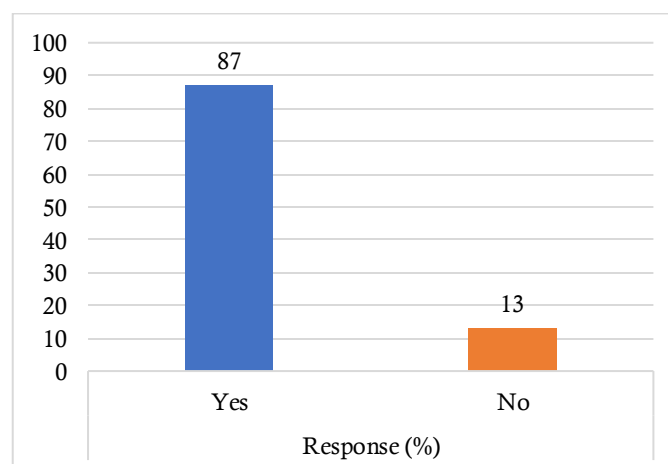


Figure 3. Discussion

According to Figure 3, 87% of students said that discussion using Trello is possible to be conducted in laboratory work. This response shows that during the activities, students are supported by Trello. It helps students discuss with their friends particularly in collecting data, organizing data, and analyzing data. It also makes them better in solving problems and reduces their anxiety during online learning through discussion (Ghasani et al., 2021). Discussion during online learning is a necessary skill in the 21st century. The 21st century learning is characterized by utilizing information technology for various activities, such as online discussion forums, to enhance students' learning activities and learning interaction (Maryuningsih et al., 2020).

Trello as a virtual learning environment is considered to be implemented to promote discussion during asynchronous learning. Teachers highlight several advantages of asynchronous learning, such as the flexibility to learn anytime and anywhere, the capacity to use a variety of learning tools, the capacity to use a variety of learning resources, and the chance to help students become more independent learners (Limiansi et al., 2020). This is supported by Vonderwell et al., 2007 Vonderwell et al. (2007) who argued that asynchronous activities enable students to learn according to each individual's capabilities and provide them with opportunities to learn independently without time or space constraints. Asynchronous learning also gives students more time to comprehend the messages, which improves their ability to process information.

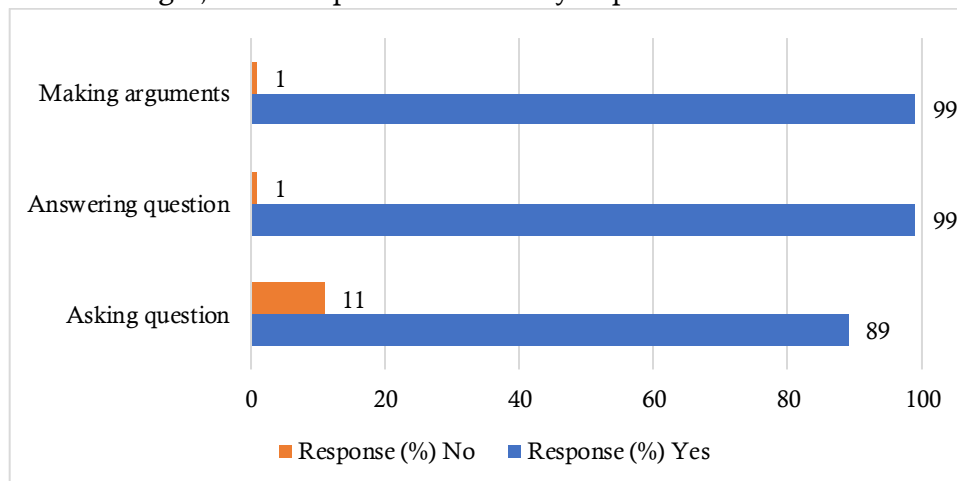


Figure 4. Communication

The features for asking question and answering question are also provided in the Trello virtual board. Students responded positively to these aspects (Figure 4) as 89 % of students agreed they can ask questions easily on the board and 99% students said they can answer questions on the board, as well. In term of making arguments, 99% students said that they can make arguments on the previous post on the board. This response shows students' enthusiasm when working using Trello because they actively communicate during the discussion session especially in discussing factors influencing human phenotype traits. This strong interest in the discussed topic will positively influence their leaning achievement (Ramadani & Simamora, 2022; Gustia & Suhartini, 2021).

In the laboratory work, there are discussion activities that are carried out asynchronously on the Trello virtual board. During this session, students can give comments on the given discussion topics. On this virtual board, students can also directly ask and answer the questions asked. In this part, students have the opportunities to discuss certain topics with their group mates. In addition, because the discussion session is text-based, it is easier for students to express their opinions and

ideas. Online discussion in virtual learning environment has many benefits for students. It can promote collaborative mindset in students. This is in line with a study by Hrastinski, 2009 in which students' participation in online learning can be characterized by four attributes. First, participation is a complex process of taking part and maintaining relations with other students. Second, participation is supported by physiological and physical tools. Third, participation is not synonymous with talking or writing. Fourth, participation may entail working together with peers, but essentially it may entail relationships of any kind. The fourth aspect is also supported by cooperative and collaborative learning theory.

Asynchronous discussion online also enhances students' engagement in learning. It is in line with the research conducted by Galikyan & Admiraal, 2019 on how the online asynchronous discussion board can be a useful tool for assessing each student's level of cognitive engagement with the educational process. Further, the study also implies that it is possible to draw the conclusion that individual student contributions to online discussions at specific levels of cognitive presence, but not all levels, are useful predictors of academic performance. Another advantage of asynchronous discussion online is that it can also enhance the interaction between students and tutors (Osborne et al., 2018). Asynchronous online discussion forums can also be designed to support knowledge construction and higher-order thinking. Asynchronous online discussion can be used as a platform to reflect and learn from other students to solve ill-structured problems (Yeong, 2021). Furthermore, online asynchronous discussion can also be combined with in-class discussion to increase students' argumentative skills (Choi & Hand, 2020).

From the results of the collected questionnaires, 95% of students stated that their experience in submitting laboratory work reports using Trello is more monitored and organized. On this virtual board, students are able to track their progress in writing the laboratory report. The instructor provides the checklist that is used by students to track their progress in every activity in this laboratory. They can also submit the report on a specific folder that allows them to upload the laboratory report file in various forms and gives them permission to edit their file and give comments or feedback on the same board.

Results show that there are several benefits in using Trello as an online collaborative tool. First, the Trello virtual board provides features that support students to exchange laboratory work data between groups. Data collected by everyone in the group can easily be well organized in one board. The class data set can also be easily accessed by all the groups. Secondly, students can easily collaborate and discuss with their group mates and their classmates. Trello provides a space for students to ask and answer questions directly on the virtual board. Questions written on the board can be accessed and answered by all students. The platform facilitates class discussions very well. The third benefit is that the final laboratory reports can be collected easily in one place. Reports can also be edited and responded by other students and instructors directly, so that getting direct feedback from the instructor is possible. Another advantage is that students can revise their reports if they have a mistake or submit an incomplete laboratory report. It is easy to use the online collaborative platform because most of the students are digital natives who use gadgets on a daily basis. Gadget-based learning models can be used as a learning strategy to attract the attention of students (Aribowo et al., 2019).

Furthermore, instructors also get benefits from Trello virtual board. Instructors can track the students' activities. The platform monitors activities that are completed by students. The progress can be seen from the activities uploaded on the virtual board. Instructors also are able to give feedback directly in the board. However, instructors should prepare the learning instructions

including student worksheets and assessment rubric completely prior to the class because the board should be available before the lesson starts. It is certainly a challenge for instructors because teachers' readiness for e-learning is crucial (Saragih et al., 2021). As for online learning, instructors play an important role in the success of learning process, followed by internet accessibility, administrative support, course content and design, technical support, learner characteristics, and social support (Saldivar et al., 2022). Teachers also should be creative so that students' learning experience becomes optimal (Tuzzahra et al., 2022). Thus, they should have the willingness to learn and be open to various learning strategies particularly during unprecedented events (Herawati et al., 2022).

During the online laboratory work with the virtual collaboration tool Trello, students also encounter obstacles. First, students are not used to using Trello and had difficulty in operating the application, especially the less familiar features, such as writing and answering questions on the discussion page, giving comments and feedback on the laboratory reports, and uploading final laboratory report files. Second, students have difficulty remembering the submission deadline of the final report because on this board they do not yet set the reminder for the deadline for submitting the final report. Third, Trello requires an internet connection. In this case, as not all students have readily available internet access, some of them cannot access the board when they want to work on the activities. Internet connection and stability has been the biggest issue during online learning (Hizqiyah et al., 2022; Nurdianti et al., 2021). Although instructors have given directions on how to use Trello before the laboratory work, students still experience some difficulties in the beginning because they are not familiarized with using the platform.

In virtual collaboration, students might experience difficulties more than in face-to-face collaboration (Hafeez et al., 2022). They might find communication breakdown, misunderstanding and difficulty moving forward compared to their experience in face-to-face collaboration (Andres & Shipps, 2010). Many challenges during virtual teamwork may be due to the loss of many verbal cues. The online environment also reduces mechanism for informal conversation and opportunities to build friendships. In terms of technology, some students might find it complicated and unreliable. However, all shortcomings in collaborative learning become a challenge. Instructors, for instance, must prepare the scenario before starting the laboratory work. In order to make effective virtual team work, at least nine components must be fulfilled; (1) realigning reward structures for virtual teams, (2) finding new ways to focus attention on task, (3) designing activities that cause people to get to know each other, (4) building a virtual presence, (5) accepting standards and terminology, (6) leveraging anonymity when appropriate, (7) being more explicit, (8) training teams to self-facilitate, and 9) embedding collaboration technology into everyday work (Nunamaker et al., 2009).

Online learning or distance learning gives a different learning experience to students. At least, there are three formats of learning experience, including individual self-paced, group-based, and a mix of both forms. In the self-paced form, the type of learning is self-directed learning, whereas in group-based form, the type of learning focuses on group collaboration, cooperation through discussions, projects, or fieldwork (Lehman & O Conceição, 2010). In addition, using professional communication tools can have a good impact on students' collaboration skills (Bakir et al., 2020). Ultimately, perceived structure of collaborative activities and peer interaction during classroom activities are positively related to perceived learning. In addition, peer interaction and perceived learning are also related to course satisfaction (Faja, 2013a).

4. Conclusion

Trello has a positive impact in supporting collaborative learning among students in online laboratory work. Trello provides various features for writing laboratory data, real-time group discussions, and submitting reports. Although Trello is relatively new for some students, collaborative activities such as group teamwork, discussion activities, asking and answering questions, and making arguments can be done well on the Trello virtual board. The results of this study indicate that Trello is perceived as an effective online collaborative learning platform. This platform is suggested to be implemented in biology laboratory work in the university settings which involves online activities. Therefore, Trello as a virtual board is recommended to be implemented in various courses especially in organizing and managing the laboratory work.

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