

Senior High School Students' Collaborative Skills through Acid-Base Chemistry Practicum Activities

Shofrina Surya Dewi^{1*}, Nurfina Aznam¹, Nur Inayah Amaliyah¹

¹Chemistry Education, Faculty of Mathematics and Natural Sciences, Yogyakarta State University, Yogyakarta, Indonesia.

Received: August 23, 2023

Revised: February 12, 2024

Accepted: April 25, 2024

Published: April 30, 2024

Corresponding Author:

Shofrina Surya Dewi

shofrinasurya.2022@student.uny.ac.id

DOI: [10.29303/jppipa.v10i4.5081](https://doi.org/10.29303/jppipa.v10i4.5081)

© 2024 The Authors. This open access article is distributed under a (CC-BY License)



Abstract: This research aims to determine collaboration skills profile of class 11 students at one of the public high schools in Paciran Regency. The reason for conducting this research is collaboration skills are one of the 21st century skills that must be mastered by students. The research conducted was descriptive quantitative with a cross-sectional survey method. The population of this study was 100 students. The sampling technique used purposive sampling technique with consideration from chemistry teachers. Collaboration skills are measured using an observation sheet containing statements according to aspects of collaboration skills. Data analysis techniques using MS Excel. Collaboration skills aspect score data was analyzed quantitatively, then converted according to calculations into the very low, low, medium, good, and very good category. The student collaboration skills profile in this research includes 8 aspects are finding solutions, responsibility, mutual respect, interdependence, cooperation, communication, listening to other people's ideas, and commitment. In this research, it was found that the best aspect of collaboration skills in the very good category was the aspect of positive interdependence at 84.30%, cooperation at 88.50% and communication at 91.00%. The research results show that the average percentage of collaboration skills for all aspects is 83.50% and is in the good category.

Keywords: Acid-base material; Chemistry practicum; Collaboration skills

Introduction

The development of 21st century technology and global competition in this century requires every individual to have skills in the form of science, expertise and technology (Haviz et al., 2018). The 21st century also has an integral educational framework model that allows us to observe and evaluate the competencies required in each scientific discipline from different dimensions such as technological, pedagogical, contextual and humanistic aspects (González & Ramírez, 2022). Education today is expected to produce qualified graduates in various fields of science and technology. Therefore, educational institutions need to prepare learning to improve the quality of education in accordance with the demands of skills in the 21st century (Majir, 2019). Skills are defined as the ability to do tasks

and solve problems. Skills demonstrate competence in applying learning outcomes in any field of education, employment, personal or professional development (González & Ramírez, 2022).

There are several factors that influence teaching practices and the achievement of learning skills results in learning, namely the form of teaching and learning, the characteristics of a constructivist learning environment, the characteristics of an integrative learning environment and the characteristics of the learning atmosphere (Lavi et al., 2021). In general, skills can be divided into 3 main areas: first, learning and innovation skills are critical thinking and problem solving, communication and collaboration, creativity and innovation. Second, digital literacy skills are information literacy, media literacy, information technology and communication literacy. Third, career

How to Cite:

Dewi, S. S., Aznam, N., & Amaliyah, N. I. (2024). Senior High School Students' Collaborative Skills through Acid-Base Chemistry Practicum Activities. *Jurnal Penelitian Pendidikan IPA*, 10(4), 1869–1877. <https://doi.org/10.29303/jppipa.v10i4.5081>

skills and living are flexibility and adaptability, initiative and self-direction, social and cross-cultural interaction, productivity and accountability. 21st century skills are classified as learning and innovation skills known as 4C which consist of creativity skills, communication skills, collaboration skills, and problem solving skills (Handajani et al., 2018). These skills can be used in solving educational problems or learning (van Laar et al., 2019). In the 21st century, all learning is required to include several learning and innovation skills. One type of learning, if viewed from the learning achievement indicators, which is closely related to several 21st century skills, is chemistry learning.

Chemistry is a natural science that studies everything about matter which includes structure, composition, dynamics, change and energy which involves skills and reasoning. Learning chemistry in high school aims to enable students to understand basic theories, principles, concepts and interrelated laws so that they are able to apply their knowledge in everyday life. Chemistry subjects are theoretical and practical which require high-level thinking skills to be able to solve numeracy problems and learning theory (Dewi et al., 2019). Chemistry learning can be carried out through various activities, one of which is practicum. Practicum plays a significant role in helping students understand chemistry concepts in a more concretely and practically. Practicum is a suitable method for teaching science concepts that are abstract in nature, but are based on scientific facts that are tested and occur in real life (Sasongko, 2020). Practicum allows students to conduct experiments and direct chemical phenomena, so that they can associate theory with real practice. However, to maximize the benefits of practicum in chemistry learning, 21st century skills must be considered. One of the skills that must be mastered in chemistry practical activities is collaboration skills. Collaboration skills are the skills of working together effectively and efficiently by showing respect for a diverse team, as well as practicing fluency and willingness in making decisions that are very necessary to achieve common goals. Teamwork consists of leadership, decision making, and cooperation (Supena et al., 2021). Student collaboration skills also play an important role in ensuring the success of practicum in better chemistry learning (Kurniaman & Noviana, 2017). Collaboration skills are inseparable from the positive contributions of members of a group (van Laar et al., 2019).

Aspects of collaboration skills have several competencies according to Coufal et al. (2018), namely communication, team accountability/responsibility, mutual respect, and assessment and intervention holistic. In addition, aspects of collaboration skills according to Shaw et al. (2017) explain that there are six criteria that must be met so that student collaboration

skills can develop, including social interdependence, solutions to solve problems, introduction new ideas, sharing resources, cooperation, communication. Based on aspects of collaboration skills from the two sources above, aspects of collaboration skills can be synthesized into communication, responsibility, mutual respect, interdependence, cooperation, finding solutions, listen to other people's ideas, share resources.

The benefits of collaboration skills are effective division of labor, integration of information from various sources of knowledge, perspectives and experience, as well as increased creativity and quality of solutions combined with group ideas (Ilma et al., 2022). Collaboration skills help students understand how to solve problems, propose solutions, and decide on good actions. In addition, collaboration skills can also be used knowing that other people do not always have the same ideas as we have (Erdoğan, 2019). The curriculum that introduces skill-oriented learning is the 2013 curriculum. In the 2013 curriculum, learning is structured in a holistic and interdisciplinary manner, encouraging students to work in teams, communicate effectively, and respect each other. Competence graduates in this curriculum are more complete covering attitudes, knowledge and skills (Kurniaman & Noviana, 2017). The 2013 curriculum provides opportunities for students to actively participate in collaborative activities, such as group projects, discussions, and practicums. Thus, the 2013 curriculum plays an important role in developing students' collaboration skills, preparing them to face the challenges and demands of an increasingly complex world of work (Redhana, 2019).

Students who have collaboration skills can be seen from being actively involved in teams so they are able to achieve a deeper understanding of the chemical concepts they have learned (Magdalena et al., 2014). Collaboration skills in chemistry practicum can affect students' motivation and learning outcomes in studying chemistry (Surayya et al., 2014). The importance of collaboration skills in practicum can affect the success of practicum and students will better understand chemical concepts. In addition, collaboration skills also have a positive impact in the context of learning chemistry in general (Cheruvellil et al., 2014). The importance of collaboration skills can also influence the effectiveness of work time to shape teaching structures and promote learning achievement (Blau et al., 2020). However, the fact is that not all educators can optimize student collaboration skills through practicum activities in chemistry learning so that students still have difficulties understanding chemical material (Siregar, 2018).

Students experience difficulties in understanding chemical concepts due to the abstract characteristics and complexity of chemical material. Therefore, it is important for students to apply collaboration skills in

learning chemistry so that it can help them understand chemical material. In addition, educators must also know interesting practicum activities to improve students' collaboration skills (Andrian et al., 2020). The chemistry learning difficulties faced by students can be overcome if team members work well and care for one another professionally and personally, have common goals and make science a top priority (Cheruvilil et al., 2014). Acid-base material is one of the chemical materials that tends to be difficult for students to understand. The topic of acids and bases is conceptually dense material and requires an understanding that is integrated into several introductory chemistry concepts. Besides that, conceptually acid-base material is also abstract, causing students to experience difficulties in understanding it (Sari & Seprianto, 2018). Based on the results of research conducted by Nurwahidah et al. (2022) stated that students often face difficulties in demonstrating effective collaboration skills when doing practicums. Students tend to work individually, communicate less with their colleagues, or are not active in sharing knowledge and experiences. This lack of collaboration skills can affect their understanding of the acid-base chemistry concepts taught in the practicum. Apart from that, research conducted by Reisoğlu et al. (2020) states that teachers' knowledge and skills in organizing learning greatly influence the improvement of students' collaboration skills.

Based on the above studies, the researcher is interested in researching the profile of collaboration skills in acid-base practicum. Therefore, this study has one research question, namely what is the profile of collaboration skills through acid-base practicum activities? Understanding students' collaboration skills, educators are expected to be able to design appropriate practicum activities to increase student collaboration engagement. In addition, a better understanding of students' collaboration skills in chemistry practicum is expected to provide insight into the success of practicum activities in the context of learning chemistry.

Method

This research is descriptive research with a quantitative approach. This research was conducted in March 2023 and took place at one of the public high schools in Paciran Regency, even semester of the 2022/2023 academic year, taking three sample classes. The sample taken in this research was 100 grade 11 students who were carrying out acid-base practicum without any control or treatment, so the research results only describe the existing characteristics. The sampling technique used was purposive sampling.

Research Procedure

The research procedure starts from the preparation stage by conducting literature studies, compiling and creating research instruments, then validating research instruments with lecturers. After that, instrument testing and analysis of the instruments to be used are carried out. The procedure continues with the implementation stage, namely data collection using observation sheets to assess collaboration skills. The final stage is processing the data, holding discussions and drawing research conclusions and writing research publications.

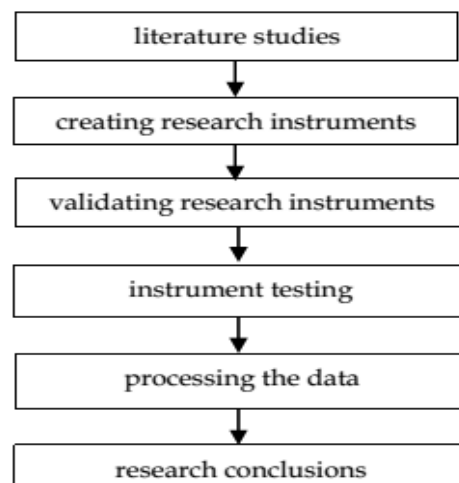


Figure 1. Research procedure

Data Collection Techniques and Instruments

The data collection technique in this research uses a collaboration skills observation sheet instrument. The instruments in this research were used to obtain research data and used as a reference to describe students' collaboration skills in acid-base practice. The instrument used was an observation sheet developed using a 1-5 Likert scale (scale 1: very bad, scale 2: poor, scale 3: sufficient, scale 4: good, and scale 5: very good) which contains 8 aspects of cooperation. skills are explained into 16 indicators. This instrument is used to determine the profile of students' collaboration skills through acid-base practical activities.

Data Analysis Technique

Collaboration skills aspect score data was analyzed quantitatively, then converted according to calculations into the following categories.

Table 1. Category of Collaboration Skills Aspect

Score Range	Category
0.00-36.00%	Very low
36.00-52.00%	Low
52.00-68.00%	Medium
68.00-84.00%	Good
84.00-100.00%	Very good

Result and Discussion

The profile of students' collaboration skills in this study includes 8 aspects are find a solutions, responsibility, mutual respect, interdependence, cooperation, communication, listening to other people's ideas, and commitment. These eight aspects were selected based on consideration of ability to observe student activities during acid-base labs. The results obtained are then tabulated and converted into percentages which can indicate the value category of each aspect. The results of observing students' collaboration skills based on the observation sheet are presented in table 1 below.

Table 2. Aspects and Indicators of Collaboration Skills

Aspect	Indicator
Find a solution	Have the initiative to find references.
Responsibility	Think creatively in solving problem solving.
	Completing practicum reports on time.
Mutual respect	Return practical tools to their place.
	Dividing practicum group assignments fairly.
Interdependence	Appreciate the differences between members of the practicum group.
	Complement each other in achieving practicum goals.
Cooperation	Interdependence in finding relevant sources to strengthen practicum results.
	Sharing ideas in doing practicum.
Communication	Contribute actively in practicum activities.
	Express opinions clearly.
Listen to other people's ideas	Actively think or give ideas.
	Listen to the opinions of other people.
Commitment	Seek to understand and accept different opinions.
	Be in a group during the practicum.
	Try to be present on time for the practicum.

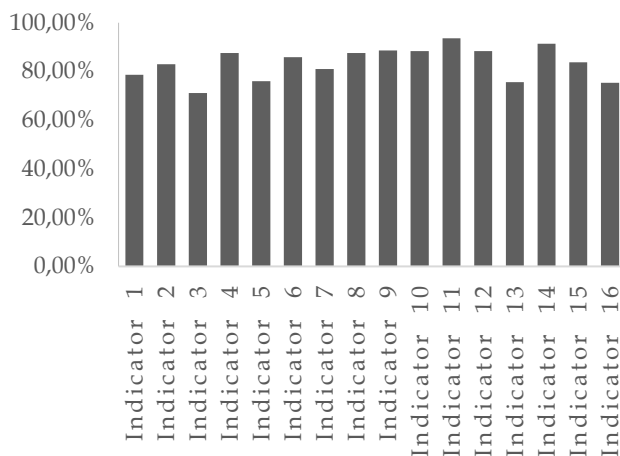


Figure 2. Graph of the percentage value of each indicator

Overall, the average indicator of collaboration skills for class XI MIPA students is 83.50% and is in the good category. This shows that students are able to demonstrate their ability to collaborate and work in practicum groups to achieve common goals. In addition, this can also show that learning acid-base practicum can train students' collaboration skills in learning chemistry.

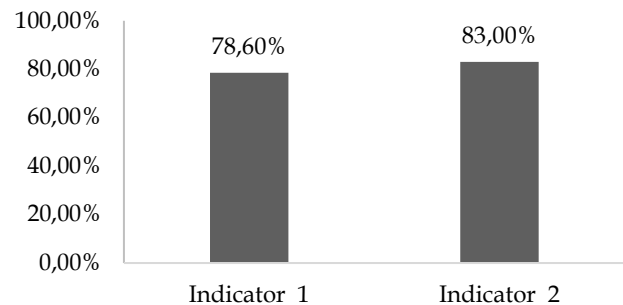


Figure 3. Graph of aspect percentage values find a solution

The average indicator in the aspect of find a solutions is 80.80% with the good category. This can indicate that students can find solutions in solving the problems they face during practicum activities. This aspect of find a solutions consists of indicators of having the initiative to seek references as much as 78.60% in the good category and indicators of creative thinking in solving problems as much as 83% in the good category. This is in accordance with the statement put forward by Palennari et al. (2021) shows that one of the demands of the 2013 curriculum is to think about find a solutions in solving problems so that the aspect of find a solutions must have a good category in order to achieve learning objectives that are in accordance with the development of students' potential. The aspect of finding solutions is a systematic approach in conceptualizing and understanding a given problem, designing strategies to solve the problem, and evaluating the strategies implemented. Finding solutions is also a very important aspect of collaboration skills between team members (Albay, 2019).

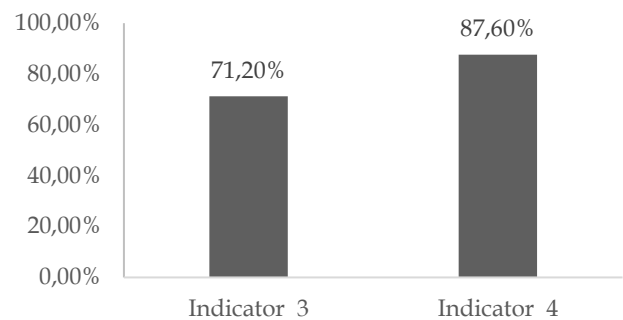


Figure 4. Graph of the percentage value of the aspect of responsibility

The average indicator in the aspect of responsibility is 79.40% with the good category. This can indicate that students can be responsible for completing the activities of the acid-base practicum group. This aspect of responsibility consists of the indicator of completing practicum reports on time as much as 71.20% with the good category and the indicator of returning practicum tools to their place as much as 87.60% with the very good category. These indicators can be observed through the attitudes and behavior of students during the practicum. This is in line with the statement put forward by Sari (2020) indicating that the aspect of responsibility can be seen as self-awareness of something that has happened or is happening, so that if students have a good awareness of something then students are able to take responsibility properly. Aspects of responsibility have also been shown to positively impact individuals psychologically, leading to a number of benefits, including greater self-esteem, improved relationships, and more effective interpersonal communication (Ayish & Deveci, 2019).

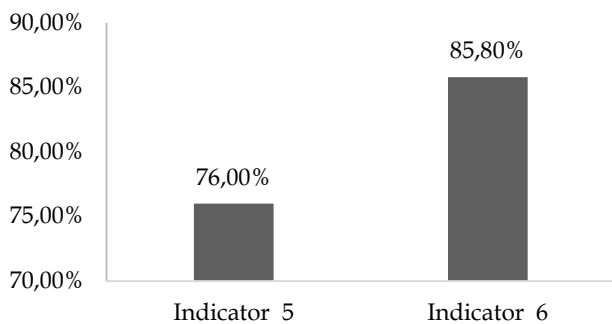


Figure 5. Graph of the percentage value of the aspect of mutual respect

The average indicator in the aspect of mutual respect is 80.90% with the good category. This can indicate that students can respect each other during the acid-base practicum group activities. This aspect of mutual respect consists of an indicator of dividing practicum group tasks fairly as much as 76.00% in the good category and an indicator of appreciating differences between members of the practicum group as much as 85.80% in a very good category. These indicators can be observed through the attitudes and behavior of students during the practicum so that observers can assess these indicators by observation. This is in line with the statement put forward by Widodo et al. (2006) showing that practicum results are influenced by mutual respect so that if students have mutual respect in the good category it will be easier to achieve practicum objectives. To ensure collaboration skills are effective, this can be done by providing constructive feedback between team members to create

an environment filled with mutual respect for each other (Wei et al., 2020).

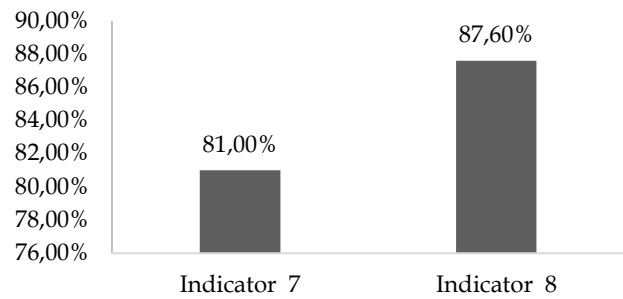


Figure 6. Graph of the percentage value of the interdependence aspect

The average indicator in the aspect of interdependence in positive terms is 84.30% with a very good category. This can indicate that students have a very good process of positive interdependence when the group activities of the acid-base practicum take place so that they can achieve the practicum goals together. This aspect of interdependence in positive terms consists of indicators complementing each other in achieving practicum objectives as much as 81.00% in the good category and indicators of interdependence in finding relevant sources to strengthen practicum results as much as 87.60% in the very good category. Observers can assess indicators of interdependence in positive terms by observing during the practicum. This is in line with the statement put forward by Hartina et al. (2022) shows that positive interdependence is one way to increase good interaction between individuals so that this aspect of interdependence trains students to do practical activities together with group members. Positive interdependence is one of the key elements of learning. Positive interdependence provides benefits for students to have the ability to learn independently because there is a significant positive relationship between positive interdependence and the ability to learn independently (Yuewu et al., 2019).

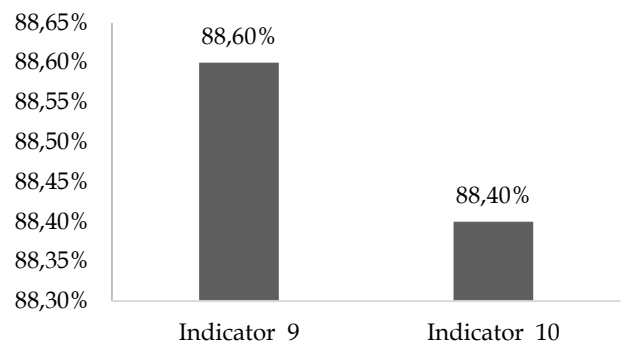


Figure 7. Graph of the percentage value of the cooperation aspect

The average indicator in the aspect of cooperation is 88.50% with a very good category. This could indicate that students who have a very good value of cooperation during the acid-base practicum group activities will complete the practicum activities more quickly. This aspect of cooperation consists of indicators of sharing ideas in conducting practicums as much as 88.60% in the very good category and indicators of actively contributing to practicum activities as much as 88.4% in the very good category. Observers can assess the two indicators of cooperation through observation during the practicum and the two indicators of cooperation have a very good value so that this greatly influences the course of the practicum process. This is in line with the statement put forward by Nadhiroh et al. (2020) indicating that this is in accordance with the theory which states that collaboration is the activity of working together to achieve one goal. One of the most important components of collaboration is cooperation.

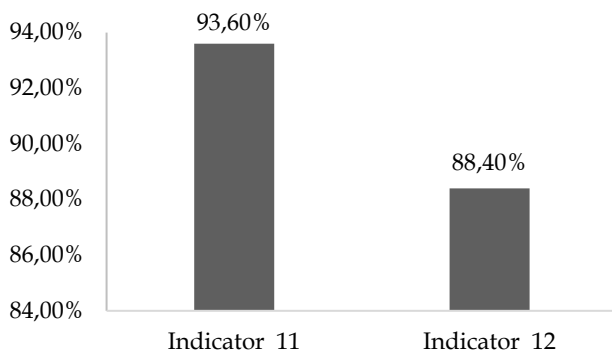


Figure 8. Graph of the percentage value of the communication aspect

The average indicator in the communication aspect is 91.00% with a very good category. This can indicate that students have a very good communication value so that the acid-base practicum activities will run smoothly because group members communicate very well with each other. This aspect of communication consists of indicators expressing opinions clearly as much as 93.60% with a very good category and active indicators giving opinions or giving ideas as much as 88.4% with a very good category. The observer can assess the two communication indicators through observation during the practicum and the two communication indicators have a very good value so that this affects the course of the practicum process because the practicum process requires good communication between members of the practicum group. This is in line with the statement put forward by the Pacific Policy Research Center (2010) indicating that communication skills refer to an individual's ability to communicate clearly, using spoken, written, and non-verbal language.

Communication is an important aspect of collaboration skills.

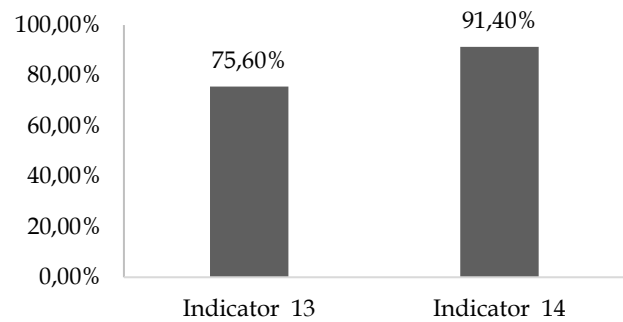


Figure 9. Aspect percentage value chart listens to other people's ideas

The average indicator in the aspect of listening to other people's ideas is 83.50% with the good category. This could indicate that students have a good value in the aspect of listening to other people's ideas because in practicum activities they have to listen to each other's opinions so that the practicum can run according to how it works in the guidebook. This aspect of listening to other people's ideas consists of an indicator of listening to the opinions conveyed by other people as much as 75.60% with a good category and an indicator of trying to understand and accept different opinions as much as 91.4% with a very good category. Observers can assess both indicators from the aspect of listening to other people's ideas through observation during the practicum and one of the indicators has a very good value so that this affects the course of the practicum process. This is in line with the statement put forward by Hidayanti et al. (2020) shows that listening to other people's ideas is an important factor in collaboration, because from the opinions of others, we will get a new understanding that is different from ours so that this aspect can help the smooth running of practicum activities.

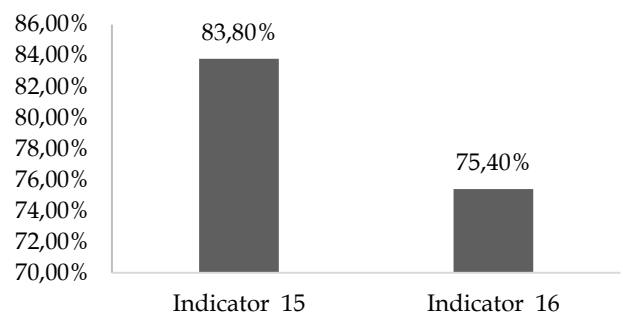


Figure 10. Commitment aspect percentage value chart

The average indicator in the aspect of commitment is 79.60% with the good category. This can

indicate that students have a good value of the commitment aspect and shows that students are able to focus on doing practicum in groups. The assessment of this indicator was also observed from the expressions of students in carrying out practicum activities. This aspect of commitment consists of indicators of being in a group during the practicum as much as 83.80% in the good category and indicators of trying to be present on time during the practicum implementation of 75.40% in the good category. Observers can assess both indicators from the aspect of commitment through observation during the practicum. This is in line with the statement put forward by Junita et al. (2021) shows that being committed to prioritizing common goals is an important factor in collaboration.

Conclusion

The collaboration skills profile of class 11 in the acid base practicum is generally in the good category, where students are able to find solutions, be responsible, respect each other, positively depend on each other, work together, communicate, listen to other people's ideas, and committed. The research results show that the average percentage of collaboration skills for all aspects is 83.50% and is categorized as good. The percentage of aspects of finding solutions is 80.80% in the good category; responsible for 79.40% of the good category; mutual respect 80.90% good category; interdependence 84.30% very good category; cooperated 88.50% in very good category; communication 91.00% very good category; listening to other people's ideas 83.50% good category; and 79.60% commitment in the good category. From these eight aspects, it can be seen that there is a relationship between indicators to show good collaboration abilities. In this research, 3 aspects of collaboration skills were found in the very good category namely aspects of interdependence, cooperation and communication. These three aspects greatly influence the collaboration skills in the acid base practicum of class 11.

Acknowledgments

During the process of completing this research, researchers received a lot of support both moral and material from various parties. Therefore, on this occasion the author would like to thank all those who have provided motivation, guidance, direction, and instructions during the process of completing this article.

Author Contributions

Conceptualized research ideas, methodological designs, data analysis, fundraising, investigative processes, writing original drafts, management and coordination responsibilities for planning and implementing research activities, S. S. D.; guided, supervised and validated the instruments used in the

research, N. A.; helped formulate the research methodology design, N. I. A.

Funding

This research is research that is independently funded by researchers, does not receive funding from outside parties.

Conflicts of Interest

The authors declare no conflict of interest. The data published in this article, both in data collection, analysis, data interpretation, in writing manuscripts or in the decision to publish research results, there is no conflict of interest with any party.

References

- Albay, E. M. (2019). Analyzing the effects of the problem solving approach to the performance and attitude of first year university students. *Social Sciences and Humanities Open*, 1(1), 100006. <https://doi.org/10.1016/j.ssaho.2019.100006>
- Andrian, D., Wahyuni, A., Ramadhan, S., Enabela, F. R., & Zafrullah, Z. (2020). Pengaruh Pembelajaran Kooperatif Tipe STAD Terhadap Peningkatan Hasil Belajar, Sikap Sosial, dan Motivasi Belajar. *Inomatika*, 2(1), 65-75. <https://doi.org/10.35438/inomatika.v2i1.163>
- Ayish, N., & Devenci, T. (2019). Student Perceptions of Responsibility for Their Own Learning and for Supporting Peers' Learning in a Project-based Learning Environment. *International Journal of Teaching and Learning in Higher Education*, 31(2), 224-237. Retrieved from <http://files.eric.ed.gov/fulltext/EJ1224347.pdf>
- Blau, I., Shamir-Inbal, T., & Avdiel, O. (2020). How does the pedagogical design of a technology-enhanced collaborative academic course promote digital literacies, self-regulation, and perceived learning of students? *Internet and Higher Education*, 45(May), 100722. <https://doi.org/10.1016/j.iheduc.2019.100722>
- Center, P. P. R. (2010). *21st Century Skills for Students and Teachers*. Honolulu: Kamehameha Schools, Research & Evaluation Division. Retrieved from www.21stcenturyskills.com
- Cheruvellil, K. S., Soranno, P. A., Weathers, K. C., Hanson, P. C., Goring, S. J., Filstrup, C. T., & Read, E. K. (2014). Creating and maintaining high-performing collaborative research teams: The importance of diversity and interpersonal skills. *Frontiers in Ecology and the Environment*, 12(1), 31-38. <https://doi.org/10.1890/130001>
- Coufal, K. L., & Woods, J. J. (2018). Interprofessional Collaborative Practice in Early Intervention. *Pediatric Clinics of North America*, 65(1), 143-155. <https://doi.org/10.1016/j.pcl.2017.08.027>

- Dewi, R. K., Wardani, S., Wijayati, N., & Sumarni, W. (2019). Demand of ICT-based chemistry learning media in the disruptive era. *International Journal of Evaluation and Research in Education*, 8(2), 265–270. <https://doi.org/10.11591/ijere.v8i2.17107>
- Erdoğan, V. (2019). Integrating 4C Skills of 21st Century into 4 Language Skills in EFL Classes. *International Journal of Education and Research*, 7(11), 113–124. Retrieved from <https://ijern.com/journal/2019/November-2019/09.pdf>
- González Pérez, L. I., & Ramírez Montoya, M. S. (2022). Components of Education 4.0 in 21st Century Skills Frameworks: Systematic Review. *Sustainability (Switzerland)*, 14(3), 1–31. <https://doi.org/10.3390/su14031493>
- Handajani, S., Pratiwi, H., & Mardiyana, M. (2018). The 21st century skills with model eliciting activities on linear program. *Journal of Physics: Conference Series*, 1008(1). <https://doi.org/10.1088/1742-6596/1008/1/012059>
- Hartina, A. W., Wahyudi, & Permana, I. (2022). Dampak Problem Based Learning Untuk Meningkatkan Keterampilan Kolaborasi dalam Pembelajaran Tematik. *Journal of Education Action Research*, 6(3), 341–347. Retrieved from <https://ejournal.undiksha.ac.id/index.php/JEAR/article/view/49828>
- Haviz, M., Karomah, H., Delfita, R., Umar, M. I. A., & Maris, I. M. (2018). Revisiting generic science skills as 21st century skills on biology learning. *Jurnal Pendidikan IPA Indonesia*, 7(3), 355–363. <https://doi.org/10.15294/jpii.v7i3.12438>
- Hidayanti, E., Savalas, L. R. T., & 'Ardhuha, J. (2020). Keterampilan Kolaborasi : Solusi Kesulitan Belajar Siswa SMA dalam Mempelajari Kimia. *Seminar Nasional Pendidikan Inklusif PGSD UNRAM 2020*, 1(1), 1–7. Retrieved from <https://prospek.unram.ac.id/index.php/inklusif/article/view/33>
- Ilma, S., Al-Muhdhar, M. H. I., Rohman, F., & Saptasari, M. (2022). Promote collaboration skills during the COVID-19 pandemic through Predict-Observe-Explain-based Project (POEP) learning. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 8(1), 32–39. <https://doi.org/10.22219/jpbi.v8i1.17622>
- Junita, A., Supriatno, B., & Purwianingsih, W. (2021). Profil keterampilan kolaborasi siswa SMA pada praktikum maya sistem ekskresi. *Assimilation: Indonesian Journal of Biology Education*, 4(2), 50–57. <https://doi.org/10.17509/aijbe.v4i2.41480>
- Kurniawan, O., & Noviana, E. (2017). Penerapan Kurikulum 2013 Dalam Meningkatkan Keterampilan, Sikap, Dan Pengetahuan. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, 6(2), 389. <https://doi.org/10.33578/jpkip.v6i2.4520>
- Lavi, R., Tal, M., & Dori, Y. J. (2021). Perceptions of STEM alumni and students on developing 21st century skills through methods of teaching and learning. *Studies in Educational Evaluation*, 70, 101002. <https://doi.org/10.1016/j.stueduc.2021.101002>
- Magdalena, O., Mulyani, S., & VH, E. S. (2014). Pengaruh Pembelajaran Model Problem Based Learning dan Inquiry terhadap Prestasi Belajar Siswa ditinjau dari Kreativitas Verbal pada Materi Hukum Dasar Kimia. *Jurnal.Fkip.Uns.Ac.Id*, 3(4), 162–169. Retrieved from <http://www.jurnal.fkip.uns.ac.id/index.php/kimia/article/view/4617>
- Majir, A. (2019). Blended Learning Dalam Pengembangan Pembelajaran Suatu Tuntutan Guna Memperoleh Keterampilan Abad Ke-21. *Sebatik*, 23(2), 359–366. <https://doi.org/10.46984/sebatik.v23i2.783>
- Nadhiroh, P. S., & Trilisiana, N. (2020). Keterampilan kolaborasi mahasiswa teknologi pendidikan dalam mata kuliah kewirausahaan berbasis proyek. *Epistema*, 1(1), 23–30. <https://doi.org/10.21831/ep.v1i1.32322>
- Nurwahidah, I., & Sari, D. S. (2022). Analisis Keterampilan Mahasiswa Pendidikan Ipa Dalam Melakukan Praktikum Dan Berkolaborasi. *EduTeach: Jurnal Edukasi Dan Teknologi Pembelajaran*, 3(2), 1–10. <https://doi.org/10.37859/eduteach.v3i2.3795>
- Palennari, M., Lasmi, L., & Rachmawaty, R. (2021). Keterampilan Pemecahan Masalah Peserta Didik: Studi Kasus di SMA Negeri 1 Wonomulyo. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, 5(2), 208–216. <https://doi.org/10.33369/diklabio.5.2.208-216>
- Redhana, I. W. (2019). Mengembangkan Keterampilan Abad Ke-21 Dalam Pembelajaran Kimia. *Jurnal Inovasi Pendidikan Kimia*, 13(1). <https://doi.org/10.15294/jipk.v13i1.17824>
- Reisoğlu, İ., & Çebi, A. (2020). How can the digital competences of pre-service teachers be developed? Examining a case study through the lens of DigComp and DigCompEdu. *Computers and Education*, 156(March). <https://doi.org/10.1016/j.compedu.2020.103940>
- Sari, C. E. (2020). Identifikasi Sikap Ilmiah Dalam Melakukan Praktikum Fisika Pada Peserta Didik Sman 12 Makassar. *Jurnal Sains Dan Pendidikan Fisika*, 16(1), 27. <https://doi.org/10.35580/jspf.v16i1.15281>
- Sari, R. P., & Seprianto, S. (2018). Analisis Kemampuan Multipel Representasi Mahasiswa FKIP Kimia Universitas Samudra Semester II Pada Materi

- Asam Basa dan Titrasi Asam Basa. *Jurnal Pendidikan Sains Indonesia*, 6(1), 55–62. <https://doi.org/10.24815/jpsi.v6i1.10745>
- Sasongko, A. (2020). Peningkatan Kualitas Pembelajaran Kimia melalui Praktikum Titrasi di SMA Negeri 5 Balikpapan. *Cendekia: Jurnal Pengabdian Masyarakat*, 2(2), 76. <https://doi.org/10.32503/cendekia.v2i2.891>
- Shaw, S., & Child, S. (2017). Utilising technology in the assessment of collaboration: A critique of PISA's collaborative problem-solving tasks. *A Cambridge Assessment Publication*, 22, 17–22. Retrieved from <http://www.cambridgeassessment.org.uk/research-matters/>
- Siregar, R. A. (2018). Validitas Pengembangan Model Pembelajaran Kimia SMA Berbasis Inkuiri Melalui Kolaborasi Kegiatan Laboratorium untuk Meningkatkan Capaian Pembelajaran Siswa pada Ranah Psikomotorik. *Jurnal Education and Development*, 6(2), 18–24. <https://doi.org/10.37081/ed.v6i2.686>
- Supena, I., Darmuki, A., & Hariyadi, A. (2021). The influence of 4C (constructive, critical, creativity, collaborative) learning model on students' learning outcomes. *International Journal of Instruction*, 14(3), 873–892. <https://doi.org/10.29333/iji.2021.14351a>
- Surayya, L., Subagia, I. W., & Tika, I. N. (2014). Pengaruh Model Pembelajaran Think Pair Share Terhadap Hasil Belajar Ipa Ditinjau Dari Keterampilan Berpikir Kritis Siswa. *E-Journal Program Pascasarjana Universitas Pendidikan Ganesha*, 4. Retrieved from https://ejournal-pasca.undiksha.ac.id/index.php/jurnal_ipa/article/view/1105
- van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2019). Determinants of 21st-century digital skills: A large-scale survey among working professionals. *Computers in Human Behavior*, 100(July), 93–104. <https://doi.org/10.1016/j.chb.2019.06.017>
- Wei, H., Corbett, R. W., Ray, J., & Wei, T. L. (2020). A culture of caring: the essence of healthcare interprofessional collaboration. *Journal of Interprofessional Care*, 34(3), 324–331. <https://doi.org/10.1080/13561820.2019.1641476>
- Widodo, A., & Ramdaningsih, V. (2006). Analisis Kegiatan Praktikum Biologi di SMP dengan Menggunakan Video. *Jurnal Penelitian Pendidikan Biologi*, 9, 146–158. Retrieved from http://file.upi.edu/Direktori/FPMIPA/JUR._PEND._BIOLOGI/196705271992031-ARI_WIDODO/2006-Analisis_kegiatan_praktikum.pdf
- Yuewu, L., & Yifan Foreign, X. (2019). Investigation Into the Relationship Between Positive Interdependence and Autonomous Learning Ability of College Students in a Normal University. *Studies in Literature and Language*, 18(1), 27–32. <https://doi.org/10.3968/10812>