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Implementing Website Simulation-Assisted Practicum on Students' Psychomotoric Learning Outcomes of Grade XI Students

Sekar Ganda Ning Tyas Arum [1], Etika Dyah Puspitasari [2,*], Much. Fuad Saifuddin [3]

Biology Education, Faculty of Teacher Training and Education, Ahmad Dahlan University, Indonesia
[1] sekarganda08@gmail.com; [2]etika.puspitasari@pbio.uad.ac.id; [3]fuad.saifuddin@pbio.uad.ac.id
* Corresponding author: etika.puspitasari@pbio.uad.ac.id

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ABSTRACT

Practicum is an important learning activity to train students' psychomotor skills. Therefore, students' ability to understand the steps and methods of practice in the laboratory must be familiarized. The use of website-based practicum simulation is one of the learning media to prepare students before entering the real laboratory. The purpose of this study was to determine the effect of website simulation-assisted practicum on students' psychomotor learning outcomes in grade XI on food ingredient test practicum. The type of research used was quasi-experiment with Posttest non-equivalent control group design. The population used was 187 students, and the sampling technique was purposive sampling. The sample used was 56 students, with XI MIPA 1 as the control and XI MIPA 2 as the experimental class. Data collection was carried out using non-test techniques to measure students' psychomotor learning outcomes. The data analysis technique used independent t-test statistical analysis. The results showed that the implementation of web-based practicum simulation had a significant effect on all four psychomotor levels. The experimental class obtained higher results than the control class. Furthermore, research can be carried out regarding the effect of using web-based practical simulations on cognitive learning outcomes, student interest in learning, scientific attitude or others.

Keywords: Practical simulation, Practical website, Psychomotor levels.

Introduction

Biology learning is one of the science learning activities that aims to provide students with the skills to understand the natural environment in depth (Sumaryanti et al., 2021). These skills can be learned through practicum activities that are carried out after the delivery of theoretical material in the classroom (Aripin & Suryaningsih, 2020). Students are expected to be able to apply biological characteristics such as understanding, applying, and analyzing knowledge obtained according to procedures through psychomotor activities. Biology learning that is only fixated on cognitive learning without being accompanied by psychomotor activities could reduce student interest in learning activities (Charis et al., 2022). Therefore, the importance of learning is not only defined as providing knowledge but also providing experience to realize understanding.

Through practicum activities, students are able to prove the theories received during lectures or discover new facts that other inventors have not proved. Through practicum activities, students will gain direct experience and knowledge when proving theories and concepts (Thahir & Magfirah, 2021). Consistent practicum activities can improve students' psychomotor learning outcomes. Sulawanti et al. (2019) revealed that practicum-based learning can improve students' psychomotor abilities. The use of practicum simulations can mentally prepare students before entering a real laboratory. This is used to introduce the conditions and procedures for utilizing tools and materials.

The utilization of the rapid development of digital technology must also be accompanied by the advancement of education, one of which is the use of learning media to support practicum activities. One uses website-based practicum simulations as a medium for learning biology (Jannah & Puspitasari, 2021). This virtual laboratory can be an alternative to practicum simulations that cannot be carried out directly. Virtual laboratories can analyze and communicate data (Aripin & Suryaningsih, 2020). Rembulan & Susanti (2021) stated that using practicum simulations in virtual laboratories aims to improve students' understanding of practicum before entering the real laboratory. Better student preparation is expected to improve student learning outcomes. Banda and Nzabahimana (2023) revealed that practicum simulation-based learning can display visualizations that help students to understand practicum activities to improve academic achievement and student learning motivation.

According to Anggrella et al. (2021), practicum activities in schools still have many problems, one of which is not using the right strategy. In addition, students' understanding of laboratory procedures and using practicum tools and materials is still not optimal. One of the steps that can be taken to anticipate these problems is to simulate practicum using a website that contains various features before practicum in the laboratory. In their research, Abdjul and Ntobui (2018) stated that one of the benefits of practicum simulation is overcoming the risk of accidents and complicated practicum and training students' skills in using information technology. In addition, virtual labs

are also able to increase conceptual understanding, self-confidence, and student motivation to enter the laboratory (Udin et al., 2020).

The selection of MAN 2 Bantul is in accordance with the psychomotor skills that will be measured in this study. This is because MAN 2 Bantul is the only skills-based MAN in the Bantul Regency, so the school emphasizes the skills of its students. Based on the results of interviews with biology teachers at MAN 2 Bantul, unfortunately, biology practicum activities have not been carried out optimally. Learning time in the classroom also inhibits practicum preparation. Therefore, using the website as an initial simulation before students enter the laboratory is expected to help them learn more optimally.

Various research studies related to virtual laboratory media show positive results. Virtual practicum media can optimize biology learning outcomes (Asy'ari & Latifah, 2021), able to simulate abstract things in practicum, and reduce accidents during real practicum (Aripin & Suryaningsih, 2020). The purpose of this study was to determine how a website-based practicum simulation affects students' psychomotor learning outcomes in grade XI on food ingredient test material at MAN 2 Bantul. The results of this study are expected to become a basic reference for teachers and schools in using web-based biology practicum simulation learning media.

Methods

This type of research is a quasi-experiment, a type of quantitative research. The research design chosen was Posttest non-equivalent control group design. The population used in this study amounted to 189 grade XI students. The sampling technique used in this study is purposive sampling, with the criteria being two classes of MIPA that have almost the same cognitive test scores. The purposive sampling technique was chosen to ensure that the two classes had almost the same knowledge and skills. A sample of 56 students was taken using the sampling technique. XI MIPA 1 class as the control class (28 students) and XI MIPA 2 (28 students) as the experimental class. Data was collected using non-test techniques to measure students' psychomotor learning outcomes. The aspects of indicator psychomotor learning outcomes are presented in Table 1.

Table 1. Indicator of Psychomotor Learning Outcomes

Level of Psychomotor	Indicators	Number
Imitation	Students follow the initial step in the experiment after seeing the demonstration.	1, 24
Manipulation	After seeing the demonstration at the beginning, students were able to practice the proper experimental procedures guided by the teacher	2-8, 11-13, 15-18, 20 & 22
Precision	Do suite experiment with independent without help from the teacher	9, 14. 19, 21
Articulation	Students present reports of experimental results correctly	23

The research instrument was a psychomotor assessment sheet that had undergone expert judgment validation involving five experts. The psychomotor assessment instrument was declared valid and reliable. The psychomotor assessment instrument uses the Gutman scale. Six observers assessed students' psychomotor skills. Statistical data analysis techniques using the Independent T-Test. Hypothesis testing using T-Test by looking at a significant level of 0.05. If the significant value <0.05, it can be interpreted that there is a significant difference between the control and experimental classes. Data analysis also uses a percentage comparison of each psychomotor level according to R.H Dave's 1970 modification by Rahman et al. (2020) which includes 4 psychomotor levels, namely P1 (imitation), P2 (manipulation), P3 (precision), and P4 (articulation). Satria (2021) used the posttest-only control design research model, which is used as a reference that is the basis for the design of this study. The design of this study is presented in Table 2.

Table 2. Research Design

Group	Treatment	Posttest
Control	X	Q1
Experiment	-	Q2

Description:

X : Classes using web-based practicum simulation

Q1 : Posttest control class

Q2 : Posttest experiment class

Results and Discussion

The posttest score data of the experimental and control classes were then processed using the SPSS 22, which consisted of normality test, homogeneity test, and hypothesis testing. The results of the normality and homogeneity tests on the Psychomotor learning outcome of the experimental and control classes are presented in Table 3.

Table 3. Normality and Homogeneity Test

	Group	Kolmogorov-Smirnov Sig.	Levene Sig.
Psychomotor learning outcome	Control	0.077	0.036
	Experiment	0.103	

Table 3, shows the results of the normality test (Kolmogorov-Smirnov) obtained; the results of the control class and the experimental class were normally distributed (sig. <0.05). Meanwhile, the homogeneity test shows that the results of the two groups are said to be inhomogeneous based on the results of the prerequisite test. Hence, the hypothesis test uses the Independent T-test parametric test. Data analysis results are presented in Table 4.

Table 4. Hypothesis independent t-test

Hypothesis	*Test*	Sig.(2-Tailed)	*Decision*
There is a significant effect of website-based practicum simulation on students' psychomotor learning outcomes.	*Independent T-Test*	0.000	significant effect

Table 4, shows the results of hypothesis testing using the Independent T-Test parametric test results of 0.000, which means a significant value <0.05, then H0 is rejected with the interpretation that there is a significant effect of the implementation of web-based practicum simulations on student psychomotor learning outcomes. After the SPSS analysis, data analysis was carried out by looking at the learning outcomes of each psychomotor level.

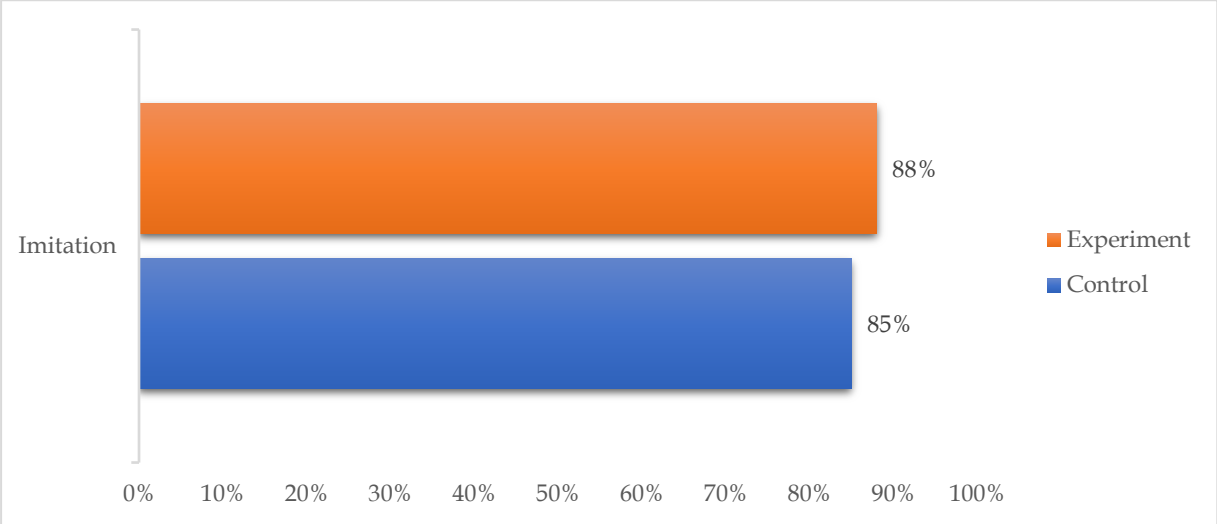

Figure 1. Percentage diagram of imitation psychomotor level

Figure 1 displays the results of the assessment of students' psychomotor skills at the imitation psychomotor level. Based on the psychomotor learning outcomes, the experimental class showed higher results at level P1 (imitation) than the control class. Imitation is one of the characteristics of skill indicators at level P1. Students will get a score at this psychomotor level if they follow the teacher's directions verbally and by demonstrating. The process is carried out through movements and directions modelled by the teacher, and then students follow along (Charis et al., 2022). Activities carried out at level P1 are selecting tools and materials and cleaning the practicum table. Practical simulation can increase students' understanding of the activities carried out at level P1. Students are more active in following the teacher's directions and understanding the form and function of tools and materials (Abdi et al., 2021). Rihi and Bano (2022) state that virtual laboratory practicum simulation can increase student activity and make learning more interactive. Furthermore, level P2 is shown in Figure 2.

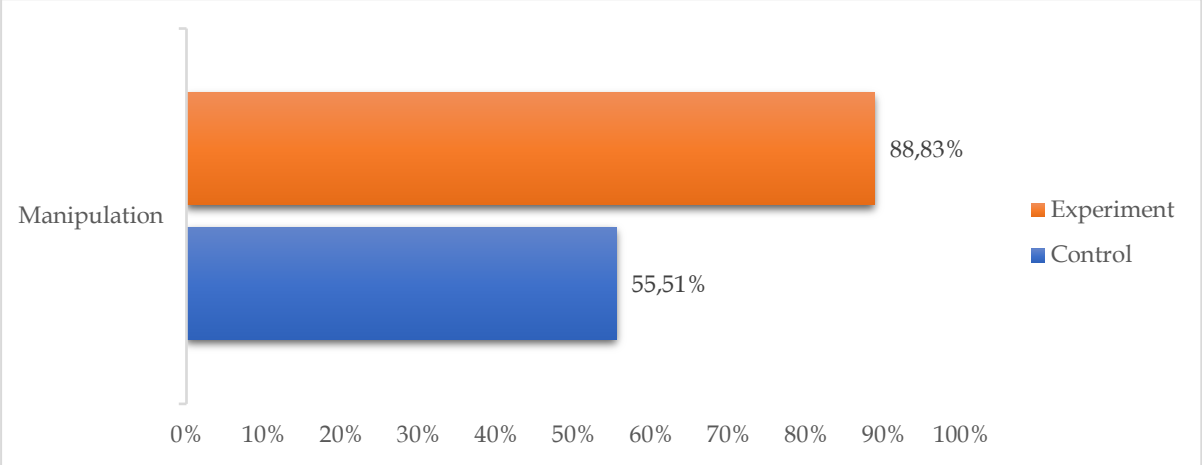

Figure 2. Percentage diagram of manipulation psychomotor level

At the P2 (manipulation) level, the experimental class learning outcomes scored higher than the control class. Skill indicators at the manipulation level show that students still carry out practicum activities by being directed by the teacher. The difference between the manipulation and imitation levels is that students will be encouraged to be more independent and braver in conducting experiments (Rahayu & Tadris, 2019). This is because, at the P2 level, students can carry out practical activities such as smoothing the ingredients, adding distilled water, dripping reagents, using a Bunsen, and heating solutions that are only given verbal directions by the teacher. Practical simulations guide students in conducting experiments in the order according to the initial instructions. Remembering and following orders are categories at the manipulation level. Therefore, practicum simulation is a learning activity that not only improves psychomotor activities, but improves students' cognition (Samsuar et al., 2023).

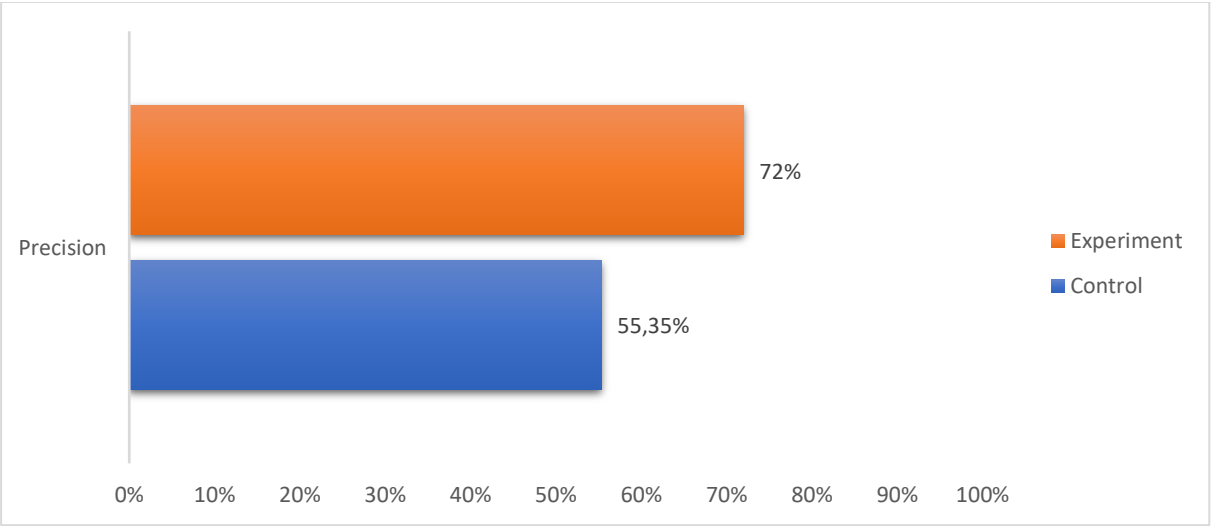

Figure 3. Percentage diagram of precision psychomotor level

Figure 3, displays the results of the assessment of students' psychomotor skills at the precision psychomotor level, the experimental class learning outcomes scored higher than the control class. It is stated that level P3 requires high precision (Sajidan et al., 2022). Simulation before practicum allows students to perform a series of practicum skills repeatedly without direction from the teacher (Sahiu & Wijaya, 2017). Practical simulation at level P3 trains students to perform skills independently (Sajidan et al., 2022). The experience that students have gained when doing practical simulations can be seen at this level of precision. Students who practice using practicum simulations will get used to doing real practicum in the laboratory (Dewi, 2022).

Swestyani and Ramadhani (2022) stated that virtual laboratories can increase student knowledge. The premise is that mastery of knowledge will improve students' skills. Based on the learning activities that have been carried out, it can be seen that students who have done practicum simulations can better follow the teacher's directions. Interaction between students can be seen when simulating practicum in the classroom. Students in the experimental class will explore information regarding practicum work steps through the website in a more organized manner. Understanding the steps of practicum work can improve student learning outcomes (Yulia & Risdianto, 2018). Understanding and remembering through practicum simulations using virtual laboratories is one of the cognitive activities. This is following research (Samsuar et al., 2023); there is a relationship between cognitive activities and student psychomotor. Good cognitive abilities can improve students' psychomotor skills, and vice versa (Sutrisno et al., 2014). The experimental class treated with practicum simulation scored higher than the control group.

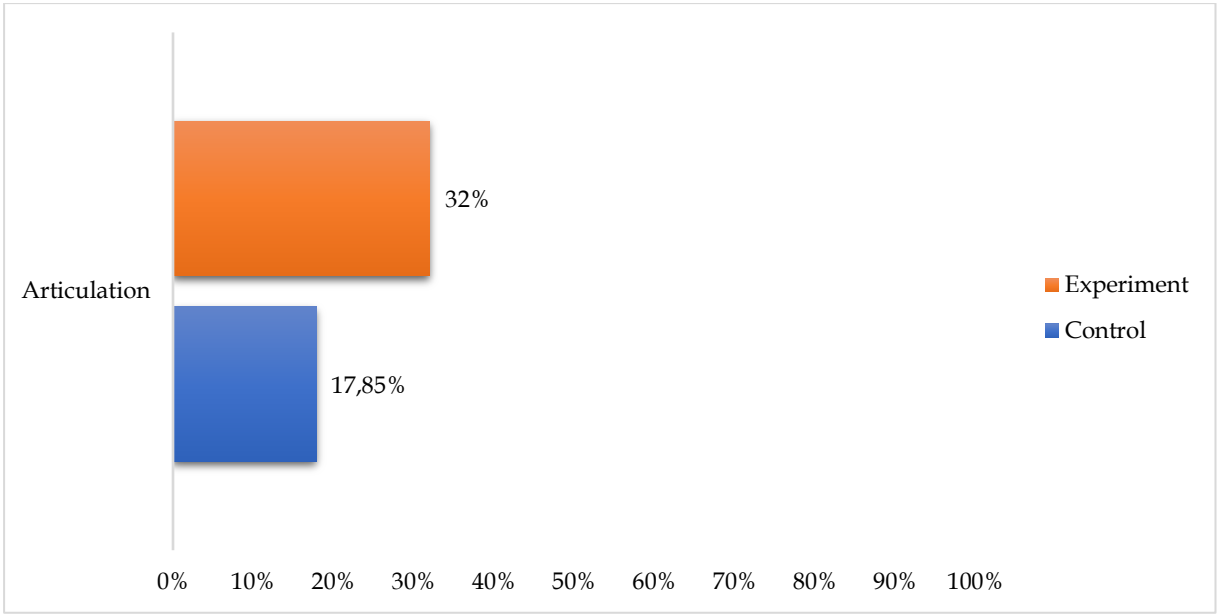

Figure 4. Percentage diagram of articulation psychomotor level

Both experimental classes had low psychomotor learning outcomes at level P4 (articulation). The thing that affects the results at level P4 is students' interest and motivation to do the task of compiling a practicum report. Krisnawati (2023) stated that some of the obstacles experienced by students when writing scientific reports are a lack of understanding of how to write, a lack of interest in reading, and low motivation. Writing reports is a new activity for students. The lack of student readiness causes students not to be accustomed to doing tasks in the form of writing reports on practicum results (Aldiyah, 2023). Therefore, web-based practicum simulation, a new activity for students, has not been able to improve student learning outcomes for writing practicum reports. The factor that influences this result is students' lack of understanding in writing reports. Based on the interview with the teacher, students have never been tasked with writing a practicum report, so students' understanding about writing is still lacking and makes the score at this level low. This is following research, according to Nicholes (2020), that report writing requires an understanding of the theory and practice that has been learned. Through continuous practice, it is possible to train students' abilities.

Based on the result of the research, it can be seen that the implementation of practicum assisted by website simulation has positive influence on students' psychomotor learning outcomes. This is evidenced by the significant difference between the experimental and control classes at the level of manipulation and precision. Practical simulation can improve student readiness before doing a practicum in a real laboratory. Students who have done practicum simulations are easier to follow and repeat practicum (Lisa et al., 2022). De Vries and May (2019) also state that virtual laboratory simulations help students visualize theory and practical laboratory work, which enhances learning outcomes. The use of this website-based practicum simulation is very influential on psychomotor learning outcomes because it can provide a real visualization of the theories and concepts obtained during class learning into a practical method (Keleş et al., 2022). The results of this research clearly show that the use of website-based practical simulations can influence psychomotor skills at each level. In previous research, such as research by De Vries and May (2019), The effect of using virtual laboratory simulations is only obtained based on student responses, not the results of the assessment of student skill aspects by observers.

Conclusion

Based on the results of data analysis and hypothesis testing, it is known that there is a significant effect at the 0.05 level of the use of website-based practicum simulations on the students' psychomotor learning outcomes of grade XI at MAN 2 Bantul. The results of the analysis showed that the psychomotor scores of experimental class students were higher than those of the control class. Based on the research that has

been conducted, the use of website simulations is able to improve students' understanding of the practicum. The experience gained when doing practical simulations makes students better understand the steps of experiments in the laboratory. From this research, it is suggested that further research can be conducted on the effect of using web-based practicum simulations on cognitive learning outcomes, student interest in learning, and scientific attitudes or others.

References

Abdi, M. U., Mustafa, M., & Pada, A. U. T. (2021). Penerapan pendekatan STEM berbasis simulasi PhET untuk meningkatkan pemahaman konsep Fisika peserta didik. *Jurnal IPA dan Pembelajaran IPA*, *5*(3), 209–218. https://doi.org/10.24815/jipi.v5i3.21774

Aldiyah, M. P., & Ramadhan, S. (2023). Pengaruh model SOLE (Self Organized Learning Environment) dan minat baca terhadap keterampilan menulis teks laporan hasil observasi. *Jurnal Basicedu*, *7*(1), 401–310. https://doi.org/10.31004/basicedu.v7i1.4650

Anggrella, D. P., Rahmasiwi, A., & Purbowati, D. (2021). Eksplorasi kegiatan praktikum IPA PGMI selama Pandemi Covid-19. *SAP Susunan Artikel Pendidikan*, *6*(1), 76-83. https://doi.org/10.30998/sap.v6i1.9612

Aripin, I., & Suryaningsih, D. Y. (2018). *Peranan Virtual Laboratory Dalam Pembelajaran Biologi*. https://www.vlab.co.in/

Asy'ari, L., & Latifah, H. (2021). Optimalisasi media virtual pada praktikum IPA dengan konsep sistem pencernaan makanan pada manusia terhadap hasil belajar siswa kelas V SDN 02 Cintanagara. *Bale Aksara: Jurnal Pendidikan Sekolah Dasar*, *2*(2), 50–60. https://doi.org/10.31980/ba.v2i2.2012

Banda, H. J., & Nzabahimana, J. (2023). The impact of Physics Education Technology (PhET) interactive simulation-based learning on motivation and academic achievement among Malawian physics students. *Journal of Science Education and Technology*, *32*(1), 127–141. https://doi.org/10.1007/s10956-022-10010-3

Choir, M. C. M., & Fikri, A. A. (2022). Persepsi siswa SMA terhadap pembelajaran biologi dalam ranah taksonomi Bloom. *Neuron (Journal of Biological Education), 2*(1), 23-32. https://ejournal.uin-suka.ac.id/tarbiyah/Neuron/article/view/21-03/2494

de Vries, L. E., & May, M. (2019). Virtual laboratory simulation in the education of laboratory technicians–motivation and study intensity. *Biochemistry and Molecular Biology Education*, *47*(3), 257–262. https://doi.org/10.1002/bmb.21221

Dewi, U. (2022). Meningkatkan aktivitas dan hasil belajar biologi materi daur ulang limbah siswa kelas X A UPT SMA Negeri Olahraga melalui pembelajaran berorientasi lifeskill. *Jurnal Pembelajaran Dan Ilmu Pendidikan*, *2*(3), 322-330. http://ojs.unublitar.ac.id/index.php/jpip/article/view/484

Jannah, F. U., & Puspitasari, E. D. (2021). Kebutuhan media pembelajaran praktikum berbasis aplikasi website pada Materi Sistem Sirkulasi Percobaan Uji Golongan Darah di masa pandemi Covid-19. *Prosiding Seminar Nasional Pendidikan Biologi*.

Keleş, D., Bulgurcu, A., Feyzioğlu Demir, E., & Şemin, I. M. (2022). The effect of virtual laboratory simulations on medical laboratory techniques students' knowledge and vocational laboratory education. *Turkish Journal of Biochemistry*, *47*(4), 529-537 https://doi.org/10.1515/tjb-2020-0619

Krisnawati, V., & Martha, N. U. (2023). Peningkatan kemampuan menulis karya ilmiah melalui project-based learning. *Multiverse: Open Multidisciplinary Journal, 2*(1), 1–6. https://doi.org/10.57251/multiverse.v2i1.906

Lisa, R., Indawan, I., & Hirza, B. (2022). Peningkatan hasil belajar siswa SMA Negeri di Lubuklinggau menggunakan laboratorium virtual. *BIODIK*, *8*(2), 162–170. https://doi.org/10.22437/bio.v8i2.17033

Nicholes, J. (2020). Lab reports and horror stories: Exploring chemistry majors' evaluations of scientific and creative writing. *Journal for Learning through the Arts*, *16*(1), n1. https://doi.org/10.21977/D916140988

Rembulan, C. N., & Susanti, L. Y. (2021). The effect of virtual laboratory implementation on the science literacy ability of class VIII students on material force and movement of objects at MTs Negeri 1 Jember. *Insecta: Integrative Science Education and Teaching Activity Journal, 2*(1). 74-86. https://doi.org/10.21154/insecta.v2i1.2715

Rahayu, F., Wahidin, W., & Cahyani, D. (2019). Analisis gaya mengajar guru biologi dan pola perilaku siswa kelas XI di SMA Negeri 1 Losarang. *Jurnal Ilmu Alam Indonesia, 2*(2), 99–111. https://www.syekhnurjati.ac.id/jurnal/index.php/jia/article/view/6797

Rahman, M. H., Iriani, T., & Widiasanti, I. (2020). Analisis ranah psikomotor kompetensi dasar teknik pengukuran tanah kurikulum SMK Teknik Konstruksi dan Properti. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *17*(1), 53-63. https://doi.org/10.23887/jptk-undiksha.v17i1.23022

Rihi, S. P. P., & Bano, V. O. (2022). Pengaruh laboratorium virtual terhadap hasil belajar siswa kelas XI pada materi sistem pencernaan makanan. *Quagga: Jurnal Pendidikan Dan Biologi*, *14*(2), 183–188. https://doi.org/10.25134/quagga.v14i2.5753

Sahiu, S., & Wijaya, H. (2017). The relationship between extrinsic learning motivation to psychomotor learning outcomes in grade V Christian subjects at Zion Makassar Elementary School. *Jurnal Jaffray*, *15*(2), 231–248. https://doi.org/10.25278/jj71.v15i2.262

Sajidan, S., Adi, F. P., Ardiansyah, R., Atmojo, I. R. W., Saputri, D. Y., & Mahendrati, G. (2022). An analysis of psychomotor assessment levels based on anderson and Krathwohl's taxonomy in integrated thematic books. *AL-ISHLAH: Jurnal Pendidikan*, *14*(3), 2945–2962. https://doi.org/10.35445/alishlah.v14i3.2168

Samsuar, S., Artika, W., Hamama, S. F., & Lubis, S. P. W. (2023). Hubungan keterampilan psikomotorik terhadap hasil belajar kognitif peserta didik dengan penerapan miksroskop smartphone berbasis pendekatan STEM sebagai alat praktikum pada materi animalia. *Jurnal Dedikasi Pendidikan*, *7*(1), 147–156. https://doi.org/10.30601/dedikasi.v7i1.3490

Satria, H. (2021). Pengaruh teknik cooperative learning berbasis metode Think Pair Share untuk meningkatkan pemahaman materi dasar-dasar Elektronika. *CIRCUIT: Jurnal Ilmiah Pendidikan Teknik Elektro*, *5*(1), 17. https://doi.org/10.22373/crc.v5i1.8085

Sulawanti, E. V., Ramdani, A., Bahri, S., & Merta, I. W. (2019). Pengaruh penerapan model pembelajaran inkuiri berbasis laboratorium terhadap kemampuan psikomotorik siswa. *Jurnal Pijar MIPA*, *14*(3), 141–147. https://doi.org/10.29303/jpm.v14i3.1039

Sumaryanti, S., Nevrita, N., & Irawan, B. (2021). Motivasi belajar siswa menggunakan cloudx pada pembelajaran biologi di SMA Negeri 1 Lingga. *Student Online Journal (SOJ) UMRAH-Keguruan Dan Ilmu Pendidikan*, *2*(2), 1152–1155.

Sutrisno, F. Z. D., Nugroho, D., & Irawati, T. (2014). Hubungan antara kemampuan kognitif dan kemampuan psikomotorik di bidang teknologi informasi dan komunikasi di SMP Negeri 21 Surakarta. *Jurnal Teknologi Informasi Dan Komunikasi (TIKomSiN)*, *2*(2).

Swestyani, S., & Ramadhani, A. N. (2022). Hydroponics virtual laboratory as an innovation in online learning media during a pandemic. *Bioedukasi: Jurnal Pendidikan Biologi*, *15*(2), 103-111. https://doi.org/10.20961/bioedukasi-uns.v15i2.62158

Thahir, R., & Magfirah, N. (2021). Development of plant physiology practicum guidelines based on learning by research for biological education students. *BIOEDUKASI: Jurnal Pendidikan Biologi*, *14*(1), 54–62. https://doi.org/10.20961/bioedukasi-uns.v14i1.45573

Udin, W. N., Ramli, M., & Muzzazinah. (2020). Virtual laboratory for enhancing students' understanding on abstract biology concepts and laboratory skills: A systematic review. *Journal of Physics: Conference Series*, *1521*(4). https://doi.org/10.1088/1742-6596/1521/4/042025

Yulia, I., & Risdianto, E. (2018). Pengembangan LKPD Berbasis Inquiry Berbantuan Simulasi Phet untuk Meningkatkan Penguasaan Konsep Gelombang Cahaya di Kelas XI MIPA SMAN 2 Kota Bengkulu. *Jurnal Kumparan Fisika*, *1*(3). https://doi.org/10.33369/jkf.1.3.64-70