Teaching on Pascal's Law: The use of experimental videos of hydraulic concepts from everyday products in the learning process for students with special needs and vocational school students

Rina Maryanti[1], Achmad Hufad[1], S. Sunardi[1], Asep Bayu Dani Nandiyanto[2**]**

[1]Departemen Pendidikan Khusus, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229 Bandung, Indonesia
[2]Departemen Pendidikan Kimia, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229 Bandung, Indonesia
[1]maryanti.rina@upi.edu, achmadhufad@upi.edu, nardilembang@upi.edu
[2]nandiyanto@upi.edu

Abstract: This study aims to determine the use of experimental videos of hydraulic concepts (Pascal's law) of everyday products in the learning process for 10 students with special needs and 10 vocational school students. We used both quantitative and qualitative methods. Experimental videos were used in the learning process for supporting demonstration activities of hydraulic concepts using tools and materials from everyday products. Pretest and posttest were carried out to determine the level of understanding of students. The results showed that the level of understanding of students had increased after using experimental videos in the learning process. The use of experimental video learning media that is tailored to the needs of the students makes it easier for students to understand the material being taught. In addition, the use of tools and materials for everyday products makes it easier for students with special needs to understand the material being taught. This is because they find it easier to understand something concrete, simple, and repetitive or they often encounter it in their daily activities. The use of experimental videos can be used as an alternative learning media for students with special needs and students in general in vocational school during the pandemic.

Keywords: hydraulic concepts, learning media, learning process, pascal's law, students with special needs, teaching, vocational school students

Corresponding Author
*Departemen Pendidikan Kimia, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229 Bandung, Indonesia
*nandiyanto@upi.edu
**Departemen Pendidikan Khusus, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229 Bandung, Indonesia
**achmadhufad@upi.edu

1. Introduction

Science learning is important for students in general in vocational high schools and students with special needs (Maryanti, 2021). One of the materials in science learning is Pascal's law. Pascal's law is one of the laws relating to liquids and the forces on them. Pascal's law reads "the pressure exerted on a liquid in a container, will be continued in all directions and is the same" (Adam & Suprapto, 2019). Pascal's law is considered important because of the relationship between the theory of liquid matter and the theory of gaseous bodies, and about changes in shape between the two which became known as the Hydrodynamic Theory (Chan & Lubchenko, 2015). Pascal's law application which is very well known is that found in hydraulic lifting tools.

Currently, there are many studies on pascal's law, pascal's law experiment tool by utilizing load cell sensors based on Arduino Uno on hydraulic jacks (Sandy et al., 2017). high school student creative thinking skills in project-based learning (Pjbl) on static fluid material (Sari et al., 2018), the profile of students' epistemological learning barriers in static fluid material in class XI SMA is based on the analysis of the respondent's ability test (Kiranti et al., 2018), exploration of the use of thinking maps to improve student's critical thinking ability on static fluid materials (Putri et al., 2018), and identification of the mastery of Archimedes law material and quizizz-aided pascal law (Anjelin et al., 2021). However, until now there has been no research that explains the use of experimental videos of hydraulic concepts (Pascal's law) from everyday products in the learning process for students with special needs and vocational students.

Learning about Pascal's law is important for students in general in vocational high schools and students with special needs. This is because knowledge of the concept of Pascal's law has many benefits and is often found in applications in everyday life. Students with special needs are children who have characteristics in both developmental and academic aspects, so they have an impact on various problems in the learning process (Maryanti et al., 2020a). The characteristics of these problems cause them to need special services and education (Maryanti et al., 2020b). The novelty in this study is the use of experimental video media regarding Pascal's law which is applied to the teaching process for students with special needs and students in general in vocational high schools. The learning process regarding Pascal's law requires experimental activities in its teaching process (Maryanti et al., 2020c). Especially for students with special needs who have the characteristics of having difficulty understanding abstract and complex material (Maryanti et al., 2020d). They need methods and media that suit their needs (Maryanti et al., 2020e). During a pandemic, the learning process is carried out online so experimental activities are difficult to carry out.

Therefore, this study aims to determine the use of experimental videos in learning law Pascal from everyday products for students with special needs and high school students. Experimental videos are used to make it easier for teachers to deliver Pascal's legal material that requires experimental activities so that students can easily understand the material being taught. We use everyday products in experimental activities because we look at the characteristics and needs of students, especially students with special needs. This research was followed by 10 students with special needs and 10 students in general at vocational high schools. To determine the level of student ability, we conducted a pretest and postest and compared the results of students with special needs with students in general. The results showed that the students' post-test scores had increased. This can be seen from the average value of the students' post-test results above 70. The experimental results of learning videos make it easier for students to understand the learning material being taught.

2. Material and Method

2.1. Research procedure

This research is limited only to the legal teaching activities of Pascal using experimental video media of everyday products for students with special needs and students in general in vocational high schools. As research subjects, we involved 10 students with special needs (students with intellectual disabilities and students with hearing impairments) and 10 students in general in vocational high schools in West Java, Indonesia. We use both qualitative and quantitative methods in this study.

Figure 1 shows the research procedure carried out. In this study, there are two stages of research, namely: Stage 1 consists of experimental activities regarding Pascal's law using everyday products and activities of making learning videos from the experimental results. Whereas stage 2 consists of preparation, namely making a learning process plan, implementing learning consists of initial activities, namely we carry out pretest activities and core activities, namely we conduct teaching using experimental video results, and we conduct evaluations or posttests as the final activity of learning.

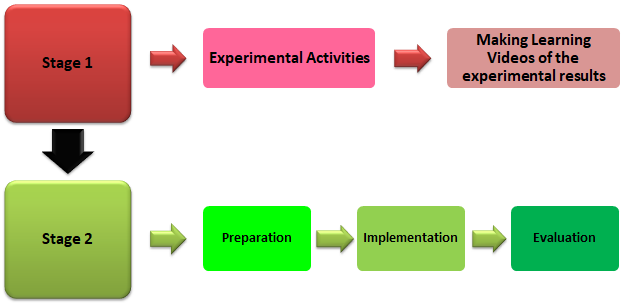

Fig. 1 Procedure Research

2.2. Research tools and materials

We used seven ingredients namely syrup (Marjan Cocopandan, PT. Lasallefood, Indonesia), cooking oil (Kunci Mas, PT. Smart Tbk, Indonesia), dishwashing liquid detergent (Sunlight, Unilever, Indonesia), floor cleaner liquid (SoKlin Lantai, PT. Wings Surya, Indonesia), concentrate liquid detergent (SoKlin Liquid, PT.Wings Surya, Indonesia), condensed milk (Indomilk, PT. Australia Indonesian Milk Industries, Indonesia), and mineral water (Le Minerale, PT. Tirta Fresindo Jaya, Indonesia).

We also used research tools, namely injections (one med, PT. Jayamas Medica Industri, Indonesia), small tubes (puso, PT. Indoteknik Dotcom Gemilang, Indonesia), rulers (butterfly, PT. Cipta Insan Kreatif, Indonesia), scissors (joyko, PT. Rahmat Indah Jaya, Indonesia), markers (sowman, PT. Altusnusa Mandiri, Indonesia), double sided tape (joyko, PT. Rahmat Indah Jaya, Indonesia), solatif (joyko, PT. Rahmat Indah Jaya, Indonesia), glue gun (joyko, PT. Rahmat Indah Jaya, Indonesia), and sterofoam (stereoform, PT. Trinseo Materials, Indonesia).

2.3. Experimental process and making experimental videos

The steps for the experimental activities were carried out, namely: (1) preparing the tools (ruler, hose, marker, and scissors), (2) measuring the hose using a 60 cm long ruler, (3) marking the hose with a marker and then scissors 60 cm long tube, (4) prepare a 60 cm tube and 2 injections (make sure one of the injection plungers is below and separate the plunger on the other injection), (5) insert the injection adapter into each end of the tube (give glue gun around it), (6) Prepare scissors, double-sided tape, and stereoform, (7) measure the double tape along the injection barrel, cut it out, and stick it on the stereoform (make two pieces and stick them parallel), (8) attach the injection barrel that is connected to the hose to the double tape on the stereoform, (9) put 20 ml of one of the ingredients (syrup / cooking oil / dishwashing liquid detergent / floor cleaner liquid /

concentrate liquid detergent / condensed milk / mineral water) into one injection barrel, then insert the injection plunger, and press, (10) observe the force applied and the injection plunger below will be lifted upwards, and (11) calculate the time it takes for the liquid in the injection barrel to move completely to the other injection barrel.

Figure 2 shows the parts of the experimental tools and materials, namely two injections consisting of a plunger, barrel, and adapter; hoses, and liquid materials. We documented all stages of a series of experimental activities for us to make learning videos.

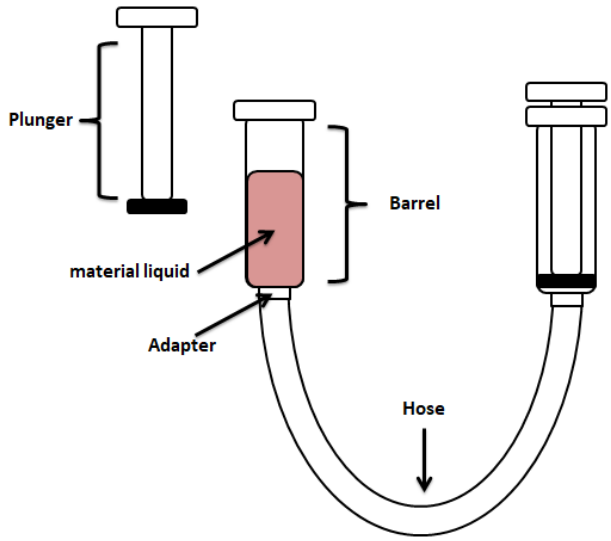

Fig. 2 Conceptual Experiment on Pascal's law

2.4. Stages of the learning process

Figure 3 shows the stages of activities in the learning process. The first is the preparation stage. The preparation stage is carried out by making a lesson plan, we determine the methods and media used. The next stage is implementation. At this stage it is divided into two activities, namely: the initial 15 minutes of learning activities, we open the learning process and do a pretest. Furthermore, the core activity is carried out for 40 minutes, we carry out the learning process supported by experimental video results. The last stage is evaluation, we carry out post-test activities by giving the same 15 questions as the pretest for 15 minutes.

Fig. 3. Learning Process

2.5. Learning Instruments

We conducted interviews, observations, documentation, and tests to determine student demographics. The test was carried out with the pre-test and post-test instruments for students. We asked 15 questions to assess the effect of using experimental videos on the level of understanding of students with special needs and students in general in vocational high schools in learning pascal law. We use an assessment score of 0 for no and 1 for yes. If the student answers yes to all questions then the total score is 100. We simplify the analysis of the student's level of understanding and all information obtained is assessed using a score scale.

Table 1. Describes the questions used at the pretest and posttest

Question	SSN		SG	
	W0	W	W0	W
1. Do you know about liquids or fluids?				
2. Do you know about the properties of liquids?				
3. Do you know some of the liquid substances in ingredients that are often found in everyday life?				
4. Do you know about Pascal's law?				
5. Did you know that Pascal's law deals with liquids?				
6. Do you know Pascal's law formula?				
7. Do you know the pressure exerted on a liquid in a container will continue in all directions and be the same?				
8. Do you know about hydraulic jacks?				
9. Do you know Pascal's law is applied to how the hydraulic jack works?				
10. Are you aware of experiments on Pascal's law?				
11. Do you know that the viscosity of a liquid affects the time it takes to drain a liquid in Pascal's law experiment?				
12. Do you know that the higher the viscosity or viscosity of a liquid the more time it takes to flow the liquid in Pascal's law experiment?				
13. Did you know that the lower the viscosity or viscosity of a liquid, the less time it takes to flow the liquid in Pascal's law experiment?				
14. Did you know that mineral water takes the least amount of time to flow and builds up the injection plunger than condensed milk in Pascal's law experiment?				
15. Did you know that the syrup takes more time to flow and lift the plunger in the injection than the mineral water in Pascal's law experiment?				
Total				

*note: SSN is students with special needs, SG is students in general, W0 is pretest value, and W is posttest value.

3. Results and Discussion

3.1. Student demographics

Figure 4 explains the percentage of subjects in this study. The subjects in this study were 20 students. 10 students are students with special needs and 10 are generally students in vocational high schools. 25% of students are students with

intellectual disabilities. Students with intellectual disabilities are students with special needs who have problems in the aspect of intelligence (IQ) below average and have problems with effective behavior (Hidayat et al., 2020). They have difficulty understanding something abstract and complex (Nandiyanto et al., 2018). Students with intellectual disabilities need habituation to have a skill. Habit or repeated teaching is sometimes needed by students. Concrete and attractive media are needed in the student learning process (Tukimin et al., 2019). The next 25% of students are students with hearing impairments. They have hearing problems that make it difficult for them to communicate and understand complex information (Maryanti et al., 2021a; Maryanti & Nandiyanto, 2023). They learn by optimizing the visual sense or visual learning. Thus, visual learning media is needed by students with hearing impairments (Maryanti et al., 2021b). Most of them have the same average intelligence (IQ) as students in general. 50% of students are students in general (normal). They have an average level of intelligence (IQ). Most of them have no problems in the learning process.

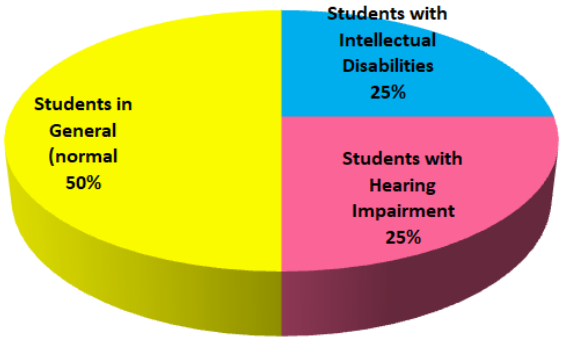

Fig. 4 The percentage of subjects in this study

3.2. Analysis of experimental data

To make it easier for students to understand the material about Pascal's law, we conducted experimental activities. Each stage of the experiment was documented and a learning video was made. Experimental videos were made to facilitate the delivery of material, especially for students with special needs and the learning process during the pandemic. This is because students with special needs, especially students with hearing impairments, learn through the visual senses. They optimize the visual sense for learning or visual learning (Susetyo et al., 2021) Experimental videos depict concrete activities and interesting impressions, thus inviting enthusiastic students to pay attention to the information presented. Especially, students with intellectual disabilities need concrete, simple, and interesting media (Rusyani et al., 2021).

In experimental activities, we use everyday products that are often found by students. It has the aim that students can easily construct the material presented because they often find these materials in the environment around them where they live. Especially for students with special needs who need applied learning (Maryanti et al., 2021). In addition, the use of these products allows students to carry out experiments independently because the materials are easily found by students.

In the experimental activity, we tried to compare the data on the level of viscosity or viscosity to the length of time it takes for the fluid to move from one injection to another as an experiment on the hydraulic concept of Pascal's law. The liquid ingredients that have a viscosity level from the highest to the lowest are condensed milk, concentrate liquid detergent, dishwashing liquid detergent, floor cleaner liquid, syrup, cooking oil, and mineral water (Maryanti et al., 2020f).

Table 2 describes the yield rate of viscosity and the time taken for each liquid in Pascal's law experiment. The liquid which has the highest viscosity level takes more time in testing Pascal's law experiments. Sweetened condensed milk takes the most time and mineral water takes the least.

Tabel 2. Describes the yield rate of viscosity and the time taken for each liquid in Pascal's law experiment

No	Material Liquid	Viscosity Level [22]	The Time It Takes to Test Pascal's Law	Pascal's Level of Law
1	Syrup	5	12.71	5
2	Cooking oil	6	09.54	6
3	Dishwashing liquid detergent	3	17.34	3
4	Floor Cleaner liquid	4	15.94	4
5	Conentrate liquid detergent	2	29.48	2
6	Condensed milk	1	01.01.90	1
7	Mineral Water	7	07.35	7

3.3. Analysis of student learning outcomes data

Figure 5 shows the data analysis of the pre-test and post-test mean scores of students with special needs and students in general in vocational schools. Students with special needs have an average pretest score of 26, while students in general are 53.3. On the results of the post-test students with special needs had an average score of 76 while students in general were 87.3.

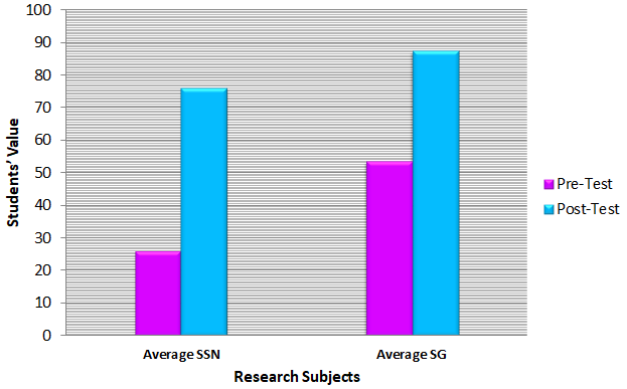

Fig. 5 Average pretest and postest

Data analysis of student learning outcomes using experimental video on legal material pascal shows an

increase in the value of the pretest and posttest. Students with special needs have increased in value by 50, while students in general have increased by 34. Students with special needs have lower pretest and postest scores than students in general. This is because students with special needs have various characteristics that cause several problems in the learning process (Maryanti et al., 2020). The difference in the student's pretest score was 27.3, while the difference in the post-test score was 11.3. Even so, the results process shows that the experimental results learning video can increase students' knowledge of the pascal material. It can be seen from the posttest scores of students with special needs and students in general are above 70.

In addition, the limitations of this study need to be considered because this research was conducted when the COVID-19 outbreak occurred online or from home studies that need additional strategies for enhancing students' comprehension (Mulyanti et al., 2020; Hashim et al., 2020; Sangsawang, 2020; Hernawati & Nandiyanto, 2021; Nasution & Nandiyanto, 2021; Huwaidi et al., 2021; Maryanti, 2021; Ganesha et al., 2021; Ramdhani & Nandiyanto, 2021).

4. Conclusion

This study discusses the use of experimental videos of hydraulic concepts in pascal law for students with special needs and students in general in vocational high schools. In this study, we conducted experiments on the concept of hydraulics using everyday products. All series of experimental activities were documented and a learning video was made. Experimental results show that high viscosity fluids take a long time to change the flow. To find out the level of understanding of our students, we did a pretest and posttest at the evaluation stage. The results show that the level of understanding of students has increased. Video of experimental results is one medium that is effective enough to improve student understanding. Although the pretest and post-test scores of students with special needs were lower than students in general, the students' scores had increased and were higher than the pretest.

Acknowledgments

We thank to RISTEK BRIN (Grant: Penelitian Terapan Perguruan Tinggi) and Bangdos Universitas Pendidikan Indonesia.

References

Adam, A. S. and Suprapto, N. (2019). One-stop physics e-book package development for senior high school learning media. iJET, 14(19), 150-158.

Anjelin, F. N., Ailiyah, F., Kurniawan, B. R. and Kholifah, M. N. (2021). Identifikasi penguasaan konsep materi hukum archimedes dan hukum pascal berbantuan quizizz. Experiment: Journal of Science Education, 1(1), 19-27.

Chan, H. Y. and Lubchenko, V. (2015). Pressure in the Landau-Ginzburg functional: Pascal's law, nucleation in fluid mixtures, a meanfield theory of amphiphilic action, and interface wetting in glassy liquids. The Journal of chemical physics, 143(12), 124502.

Ganesha, P., Nandiyanto, A. B. D., and Razon, B. C. (2021). Application of online learning during the Covid-19 pandemic through zoom meeting at karya mekar elementary school. Indonesian Journal of Teaching in Science, 1(1), 1-8.

Hashim, S., Masek, A., Abdullah, N. S., Paimin, A. N., and Muda, W. H. N. W. (2020). Students' intention to share information via social media: A case study of COVID-19 pandemic. Indonesian Journal of Science and Technology, 5(2), 236-245.

Hernawati, D., and Nandiyanto, A. B. D. (2021). The use of learning videos in order to increase student motivation and learning outcomes during the COVID-19 pandemic. ASEAN Journal of Science and Engineering Education, 1(2), 77-80.

Hidayat, D. S., Rakhmat, C., Fattah, N., Rochyadi, E., Nandiyanto, A.B.D. and Maryanti, R.; (2020). Understanding Archimedes law: What the best teaching strategies for vocational high school students with hearing impairment. Journal of Technical Education and Training, 12(1), 229–237.

Huwaidi, F., Nandiyanto, A. B. D., and Muhammad, N. (2021). The urgency of online learning media during the Covid-19 pandemic at the vocational school in Indonesia. Indonesian Journal of Educational Research and Technology, 1(2), 35-40

Kiranti, G. A., Rusnayati, H., Wijaya, A. F. C. and Siahaan, P. (2018). Profil hambatan belajar epistimologis siswa pada materi fluida statis kelas XI SMA berbasis analisis tes kemampuan responden. WaPFi (Wahana Pendidikan Fisika), 3(2), 19-24.

Maryanti, R. (2021). Assessment of mathematical abilities of students with intellectual disabilities during the COVID-19 pandemic. Indonesian Journal of Community and Special Needs Education, 1(2), 47-52.

Maryanti, R., Hufad, A., Nandiyanto, A. B. D. and Tukimin, S. (2021b). Teaching the corrosion of iron particles in saline water to students with special needs. Journal of Engineering Science and Technology, 16(1), 601-611.

Maryanti, R., Hufad, A., Sunardi, and Nandiyanto, A. B. D. (2020c). Experimental demonstration of colligative properties of solution on material phase transition to students with intellectual disabilities. International Journal of Psychosocial Rehabilitation, 24(8), 3610-3623.

Maryanti, R., Hufad, A., Sunardi. and Nandiyanto, A. B. D. (2020a). Understanding Covid-19 particle contagion through aerosol droplets for Students with special needs. Journal of Engineering Science and Technology, 15(3), 1909-1920.

Maryanti, R., Hufad, A., Sunardi., Nandiyanto, A. B. D. and Manullang, T.I.B. (2020b). Understanding coronavirus (COVID-19) as a small particle to students with special needs, Horizon, 2(1), 121-130.

Maryanti, R., Hufad, A., Tukimin, S., Nandiyanto, A. B. D. and Manullang, T. I. B. (2020f). The importance of teaching viscosity using experimental demonstration from daily products on learning process especially for students with special needs. Journal of Engineering Science and Technology, 15, 19-29.

Maryanti, R., Nandiyanto, A. B. D., Hufad, A. and Sunardi, S. (2021a). Science education for students with special needs in Indonesia: From definition, systematic review, education system, to curriculum. Indonesian Journal of Community and Special Needs Education, 1(1), 1-8.

Maryanti, R., Nandiyanto, A. B. D., Manullang, T. I. B., Hufad, A. And Sunardi (2020d). Adsorption of dye on carbon microparticles: Physicochemical properties during adsorption, adsorption isotherm and education for students with special needs. Sains Malaysiana, 49(12), 2977-2988.

Maryanti, R., Nandiyanto, A. B. D., Manullang, T. I. B., Hufad, A. and Sunardi (2020e). Education and information about COVID-19 for improving students with special needs knowledge in Indonesia. Public Health in the 21st Century. USA. Nova Science Publisher, (Chapter 11),127-140.

Maryanti, R., and Nandiyanto, A. B. D. (2023). Curriculum development in science education in vocational school. ASEAN Journal of Science and Engineering Education, 1(3), 151-156.

Mulyanti, B., Purnama, W., and Pawinanto, R. E. (2020). Distance learning in vocational high schools during the covid-19 pandemic in West Java province, Indonesia. Indonesian Journal of Science and Technology, 5(2), 271-282.

Nandiyanto, A. B. D., Asyahidda, F. N., Danuwijaya, A. A., Abdullah, A.G., Amelia, N. I. A., Hudha, M. N. and Aziz, M. (2018). Teaching "Nanotechnology" for elementary students with deaf and hard of hearing. Journal of Engineering Science and Technology, 13(5), 1352-1363.

Nasution, A. R., and Nandiyanto, A. B. D. (2021). Utilization of the google meet and quiziz applications in the assistance and strengthening process of online learning during the COVID-19 pandemic. Indonesian Journal of Educational Research and Technology, 1(1), 31-34

Putri, U. D., Parno, P. and Supriana, E. (2018). Eksplorasi penggunaan thinking maps untuk meningkatkan kemampuan berpikir kritis siswa pada materi fluida statis. Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan, 3(5), 581-587.

Ramdhani, T., and Nandiyanto, A. B. D. (2021). The use of Whatsapp social media as reinforcement online learning during the COVID-19 pandemic. Indonesian Journal of Multidisciplinary Research, 1(1), 107-112.

Rusyani, E., Maryanti, R., Utami, Y. T. and Pratama, T. Y. (2021). Teaching science in plant structure for student with hearing impairments. Journal of Engineering Science and Technology, 16(2), 1577-1587.

Sandy, A. S., Putriardi, I. M. T., Afifah, M., Kusumawardhani, P. and Pambuka, R. N. (2017). Alat eksperimen hukum pascal dengan memanfaatkan sensor load cell berbasis arduino uno pada dongkrak hidrolik. Jurnal Fisika, 7(1).

Sangsawang, T. (2020). An instructional design for online learning in vocational education according to a self-regulated learning framework for problem solving during the CoViD-19 crisis. Indonesian Journal of Science and Technology, 5(2), 283-198.

Sari, W. P., Hidayat, A. and Kusairi, S. (2018). Keterampilan berpikir kreatif siswa SMA dalam pembelajaran project-based learning (Pjbl) pada materi fluida statis. Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan, 3(6), 751-757.

Susetyo, B., Maryanti, R. and Siswaningsih, W. (2021). Students with hearing impairments'comprehension level towards the exam questions of natural science lessons. Journal of Engineering Science and Technology, 16(2), 1825-1836.

Tukimin, S., Handayani, D., Alimin, Z. and Somad, P. (2019). Indonesia deaf and blind communication system (IDBC-system). Education and Information Technologies, 24(3), 2017-2033.