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Blended Learning Integrated with Project-Based Learning: Its Effect on Learning Outcomes, Perception, and Self-Regulated Learning

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ABSTRAK

Tuntutan pembelajaran kimia memerlukan tindakan langsung berupa praktikum agar sesuai dengan pemahaman konsep kimia, menelaah teori yang diperoleh dan menghubungkannya dengan fenomena ilmiah sehari-hari melalui kegiatan ilmiah di laboratorium. Sehingga tercapai hasil belajar kognitif, afektif, dan psikomotorik. Penelitian ini merupakan jenis penelitian deskriptif kualitatif. Penelitian ini menyelidiki persepsi siswa dan Self-Regulated Learning (SRL) pada Pembelajaran Berbasis Proyek blended learning terpadu yang mempengaruhi hasil belajar siswa. Subyek penelitian adalah sembilan orang mahasiswa yang mengikuti mata kuliah kimia dasar. Penelitian ini dilakukan selama tujuh kali pertemuan dimana proses pembelajaran dilakukan dengan campuran perkuliahan online dan offline yang disebut Blended Learning. Pengumpulan data dilakukan melalui wawancara untuk mengetahui persepsi siswa terhadap Blended Learning dan kuesioner untuk mengetahui tingkat SRL siswa. Tes Learning Outcome (LO) berupa tes kognitif, afektif, dan psikomotorik. Data hasil wawancara dianalisis secara induktif. Sedangkan analisis data SRL dan uji LO disajikan sebagai gambaran yang terintegrasi dan komparatif. Wawancara siswa mengungkapkan persepsi positif tentang pembelajaran. Penelitian ini menemukan bahwa SRL siswa berada pada kategori tinggi (56%), sedang (33%), dan rendah (11%). Penilaian LO diperoleh dari pre-test dan post-test; semua nilai siswa meningkat. Untuk sikap, pengukuran menunjukkan empat kategori: sangat baik (67%), baik (11%), cukup (11%), dan kurang baik (11%). Penilaian instrumen yang dirancang menunjukkan bahwa 67% instrumen dikembangkan sementara 33% lainnya kurang berkembang.

ABSTRACT

The demands on chemistry learning require hands-on action in the form of practicums to fit understanding of chemical concepts, examine the theories obtained and relate them to everyday scientific phenomena through scientific activities in the laboratory. So that cognitive, affective, and psychomotor learning outcomes are achieved. This research is a type of qualitative descriptive research. This study investigates student perceptions and Self-Regulated Learning (SRL) on integrated blended learning Project Based Learning that affects student learning outcomes. The research subjects were nine people students who were enrolled in basic chemistry courses. This research was conducted for seven meetings where the learning process was carried out with a mixture of online and offline lectures called Blended Learning. Data collection was conducted through interviews to determine student perceptions of Blended Learning and a questionnaire to determine the student's SRL level. Learning Outcomes (LO) tests were in the form of cognitive, affective, and psychomotor. The interview data were analyzed inductively. Meanwhile, the SRL data analysis and the LO test are presented as an integrated and comparative description. Students' interviews revealed positive perceptions about the learning. This study found that the students' SRL were in the high (56%), medium (33%), and low (11%) categories. The LO assessment was obtained from the pre-test and post-test; all students' scores increased. As for the attitude, the measurements showed four categories: very good (67%), good (11%), adequate (11%), and poor (11%). Assessment of instruments designed showed that 67% of the instruments were developed while another 33% were underdeveloped.

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1. INTRODUCTION

The rapid development of science and technology must be utilized in various aspects of life, including education (Agustina & Dian, 2012; Dwiningsih & Mangengke, 2021). Changes in the education system can be influenced by technological developments or conditions that force changes (Antara et al., 2022; Ginns & Ellis, 2009). The pandemic that has been happening in the past two years resulted in the learning system having to adapt to the situation, which minimizes direct physical encounters. This condition is not surprising in developed countries because they have already started using ICT for learning before the pandemic (Dewi et al., 2022; Pradita et al., 2022). Students rarely depend on in-person meetings because there are conditions when they cannot meet their teacher in class due to illnesses or other conditions. However, they can still catch up with the lessons via online learning.

Technology is a solution for transferring information from lecturers to students and fellow students. However, technology is only a means of delivering information. A learning process is not only limited to transferring information, but there are other activities such as reading references, observing, questioning, responding, experimenting, collecting data, and communicating (Pedaste et al., 2015). Therefore, distance learning must integrate collaboration between the academic team, content, and technology (Yustina et al., 2020). The challenge of learning in the 21st-century deals with communication and information technology. Therefore, ICT utilization in education must be initiated and developed continuously so students are familiar with the technology and have information technology literacy skills useful for future careers (Subekti et al., 2018).

Chemistry learning has specific characteristics that require hands-on action in the form of practicum (Shidiq et al., 2019). Practicum is carried out so that the necessary meaningful learning occurs to establish a complete understanding of chemical concepts, examine the theories obtained and relate them to everyday scientific phenomena through scientific activities in the laboratory (Shidiq et al., 2019). Practicum activities should ideally be carried out face-to-face because in this activity a lecturer can assess the ability of cognitive, psychomotor and affective aspects at once (Khoiroh et al., 2021; Prabha, 2016). The problem of achieving the three chemistry learning outcomes cannot be resolved if only relying on online learning so that other ways are needed to overcome them (Phuapan et al., 2016). Based on analyses of the advantages and disadvantages of traditional learning and network-based learning by local and foreign researchers led to a proposed new model, i.e., blended learning, which combines the two methods to be applied in chemistry learning (Bi & Shi, 2019).

Blended learning is a learning model based on constructivism theory where each individual independently builds their knowledge (Romero et al., 2013; Schunk, 2012). The availability of learning resources from the internet can maximize blended learning when combined with learning media, structured learning using modules, and practice (Zou et al., 2012). ICT-based learning is more efficient in terms of time and facilities. Time-efficient is related to the ease of accessing learning materials because the material is uploaded to the system that enables it to be accessed by students anytime and anywhere (Abdullah, 2012). Blended learning combines formal and informal learning, offline and online communication, and guided activities where independent goal achievement plays a significant role in determining learning success (Moore et al., 2011). The blended learning model relies on three pillars, i.e., traditional direct interaction between participants of the learning process, technology-mediated interaction, and independent teaching (Krasnova & Shurygin, 2019; Macdonald, 2008). Blended learning demands SRL, i.e., the ability of students to plan, organize activities independently, seek, select, and analyze information, as well as make decisions (Moore et al., 2011).

Lecturers still have a significant role in implementing quality ICT-based learning a\d ensuring the achievement of the expected learning objectives (Dunlosky et al., 2013). The learning outcome indicates whether the student achieved the expected learning objectives. Therefore, lecturers must design a suitable learning model to enable students to obtain optimal learning outcomes (Masino & Zarazúa, 2016). Apart from cognitive learning outcomes, positive attitudes must also be built, such as discipline, enthusiasm, high learning motivation, responsibility, and SRL, i.e., an independent learning arrangement that is vital for future success (Hammond et al., 2019; Mcfarlane, 2013). SRL is a student's self-regulating ability to achieve academic success as indicated by the ability to set goals, determine intelligent strategies to achieve goals, and self-evaluation. Students with good SRL skills have a solid ability to plan study time and consistently adhere to it. Students are also accustomed to independent learning and rarely depend on teachers but are accustomed to using internet technology as a source of information (Zimmerman, 2008).

Another aspect that influences the learning process is the student's experience in blended learning which can be viewed from the student's perception of this learning model (Ginns & Ellis, 2009). Perception is the experience of objects, events, or relationships obtained by inferring information and interpreting messages (Darmaji et al., 2020). There are four aspects of perception, namely: a) Cognitive, which includes thinking, organizing, and storing information; b) Affective, i.e., feelings that affect how one perceives something; c) Interpretive, i.e., the extent to which individuals interpret something; and d) Evaluative, i.e., judging something as a good or bad aspect (Bell, 2001).

Optimizing blended learning requires integrating learning models that require students to learn actively and independently, have good communication skills with peers, and are responsible for their tasks (Kokotsaki et al., 2016). One of them is the project-based learning (PjBL) model. The PjBL model supports the achievement of 21st-century competencies, i.e., critical thinking skills, problem-solving skills, creativity, and independent learning (self-regulated learning) (Bell, 2001; Rahardjanto et al., 2019; Zubaidah et al., 2017). The application of PjBL in blended learning allows ample space to design the expected learning products (Husamah, 2015). The benefits of blended learning integrated with other learning models, such as PjBL, need to be continuously studied using the parameters of critical thinking skills, creativity, and learning motivation (Rahardjanto et al., 2019; Yustina et al., 2020). This study examines the effect of blended learning using PjBL based on students' perceptions of blended learning and self-regulated learning. The study also assesses the effect on learning outcomes, demonstrated by the ability to design innovative alternative practicums for knowledge development.

2. METHOD

This research is a qualitative descriptive study. It investigates students' perceptions and self-regulated learning (SRL) on blended learning integrated with project-based learning. It also investigates the cognitive, affective, and psychomotor learning outcomes. This study was conducted through a series of blended learning-PjBL conditions, i.e., a combination of online learning using Google Meet and direct meetings (offline) in the subject of Basic Chemistry 1. Nine participants (seven female and two male) were students registered in Basic Chemistry 1 at the Faculty of Teacher's Training and Education of the Islamic University of North Sumatra (UISU). This study had seven meetings, i.e., four online meetings and three in-person meetings. The meeting time for the lecture was 45 minutes, three times per week. For confidentiality purposes, participants were labeled with initials (M1, M2, M3, ... M9) (Fraenkel & Wallen, 2006).

Data were collected via interviews to determine students' perceptions of blended learning and questionnaires to determine the student's SRL level. Cognitive learning outcomes were evaluated based on pre-test and post-test scores. The affective achievement was observed through peer assessment to assess student attitudes related to discipline, cooperation skills, communication skills, and responsibility. The psychomotor achievement was assessed by evaluating the design of the electrolyte and non-electrolyte solution testing instrument. The parameters of psychomotor assessment are 1) Instrument design: easy to understand, easy to use, using components that are easily obtained, and available explanation of each component; 2) The physical form of the product: the instrument is built based on the design, can be operated, the components are organized, and simple application; 3) Report preparation. The psychomotor assessment categories are undeveloped, underdeveloped, developed, and well-developed (Gunbatar et al., 2018).

Interview data were analyzed inductively (Densin & Lincoln, 2009). The process involved identifying themes from all data by repeatedly reading the interview transcripts until the researcher had a clear idea of the themes from the interviews. This technique helps researchers achieve data management and data reduction goals (Palys & Atchison, 2014). Questionnaires and learning outcomes were analyzed and presented as integrated descriptions and comparisons, which compared the result of data analysis described with data interpretation to answer the research problem. The data obtained from the description results were compared and discussed based on a theoretical basis.

3. RESULT AND DISCUSSION

Result

A series of lectures using blended learning integrated with PjBL were conducted to investigate student perceptions and SRL, as well as their effect on cognitive, affective, and psychomotor learning outcomes. Table 1 describes the blended learning activities integrated with PjBL for the subject Basic Chemistry 1.

Table 1. Lectures Using Blended Learning Integrated with PjBL

Meeting	Learning Objectives	Topic	Learning Method	Learning Media
I & II	Students can analyze chemical bonds formed in chemical compounds	Ionic bonds, Covalent bonds, and Hydrogen bonds	Online, Discussion and Exercises	Modules and Learning Video

Meeting	Learning Objectives	Topic	Learning Method	Learning Media
III	Students can name chemical compounds	Inorganic compound naming (ionic compounds, acidic compounds, and binary molecule compounds)	Online, Discussion and Exercises	Modules and Learning Video
IV	Students can identify reactions in aqueous solutions.	Precipitation reactions, Gas-producing reactions, Acid-base reactions, Oxidation-reduction reactions	Online, Discussion and Exercises	Modules and Learning Video
V - VI	Students can design an alternative instrument to test electrolyte and non-electrolyte solutions.	Electrolyte and non-electrolyte solutions, Electrical conductivity of the electrolyte and non-electrolyte solutions, electrolyte and non-electrolyte reactions	In-person meeting, Practicum, Discussion, Exercise-PjBL	Modules, Learning Video, Student Worksheet
VII	Students can collect trial data from experimental instruments.	Conductivity experiments using HCl, NaOH, and salt solutions at various concentrations	In-person meeting, Practicum, Discussion, and Mini research	Learning Video and Student Worksheet

The first to fourth lectures were conducted online using Google Meet with PowerPoint teaching materials systematically designed with attractive appearances and striking color settings to make the presentation look interesting. Learning videos were prepared to complement the online learning process so that students could study the lectures independently. The communication during online learning used the UISU e-learning application and WhatsApp groups.

To prepare students to design alternative testing instruments for electrolyte and non-electrolyte solutions, they were given introductory lessons about chemical bonds, chemical reactions, and identification of electrolyte and non-electrolyte compounds in water based on their chemical bonds. The learning method used at the first four meetings were lectures, practicums, discussions, and exercises. The next three meetings were project-based learning, i.e., designing a conductivity testing instrument for electrolyte and non-electrolyte solutions. At the seventh meeting, the instrument was tested in electrolyte solutions with variations in the solution and concentration.

The fifth to the seventh meetings were conducted directly using a project-based learning approach. The modified PjBL procedure is presented in Table 2.

Table 2. Modified PjBL Procedure

Stage	PjBL Procedure	Activity
I	Determine the fundamental question (start with the essential question)	The learning process starts with watching a video (https://youtu.be/jg2uJFa8EVo) about electrolyte and non-electrolyte solutions. After watching the video, students are given the assignment to explain the video. Students are asked to construct a fundamental question based on the video and references. Which electrolyte solution is the strongest conductor? Is there an association between the chemical bond of the tested compounds with the conductivity in water?
2	Preparing the project plan	Based on the literature study (journal articles), students design a method for testing electrical current generated from electrolyte solutions. Determining the compounds to be tested for their conductivity in water.

Stage	PjBL Procedure	Activity
3	Designing the project and monitoring project design	The lecturer monitors the project completion process. A peer assessment forum is provided as part of the PjBL implementation.
4	Project Assessment	Assessment of the instrument
5	Project Testing	The prepared instrument is used to test the conductivity of HCl, NaOH, CH2COOH, alcohol, CCl4, and salt. The result is analyzed and concluded.

The blended learning lectures integrated with project-based learning activities generated data on student perception obtained via interviews, as presented in Table 3. The interview questions referred to four aspects of perception, namely: a) Cognitive includes thinking about, organizing, and storing information; b) Affective, i.e., our feelings that affect how we perceive things; c) Interpretive, i.e., the extent to which individuals interpret something; and d) Evaluative, i.e., assessing something as a good or bad aspect (Bell, 2001). The results of the interviews were analyzed using open coding (Corbin & Strauss, 2008).

Table 3. Student Perception of Blended Learning-PjBL

Code	Code Description	Interview
Experience in virtual learning	The respondent informs the conveniences (positive aspects) and the challenges (negative aspects) of virtual learning.	Positive aspects of virtual learning: 1. Easy to do, meaning that we do not have to waste time traveling for in-class lectures; thus, more time-efficient. 2. Getting used to searching for information on the internet to complete assignments. 3. Obtain knowledge of online learning applications. Negative aspects of virtual learning: 1. Unstable network connection. 2. Insufficient data plan. 3. Challenging to understand lessons delivered virtually due to unstable connection and poor internet service.
Learning materials	Virtual learning requires learning materials to enable students to understand the lesson.	Teaching materials are provided for each virtual lecture in PowerPoint slides and modules, which are provided for each virtual lecture. However, teaching materials in PowerPoint slides are difficult to understand because they are only outlines and need a direct explanation from the lecturer. For the lessons that I do not understand, I search independently for sources from the internet.
Note-taking in virtual lectures	Student's response regarding note-taking in virtual lectures.	Note-taking is also needed in virtual lectures. For me, taking notes is helpful to review lessons and re-write the teacher's explanation using my language.
Meaning of assignments	Student's response regarding assignments during virtual learning.	The assignments become means of enrichment in understanding the lesson and are challenging to complete.
Meaning of quizzes	Student's response regarding quizzes during virtual learning.	To train problem-solving skills and as a means to determine the level of understanding of the lesson.
Blended learning	Student's opinions on overcoming the limitations of virtual learning.	A preferred learning option because more flexible in its implementation, saves time, and students become accustomed to independent study based on the lecturer's direction. Communication limitations in online lectures are solved when students meet lecturers in person. Matters that are not understood during virtual lectures can be discussed when meeting in person.

The interviews regarding student perception of blended learning provided several descriptions. First, there is convenience in its implementation, i.e., do not have to be in the same room; therefore, students can attend lectures anywhere. It is also time-efficient. However, online lectures have disadvantages due to the data plan, network, and miscommunication issues. Second, students still take neat notes from online lectures, as shown in Figure 1. Third, students have a positive perception of assignments and quizzes. Fourth, have positive responses to blended learning.

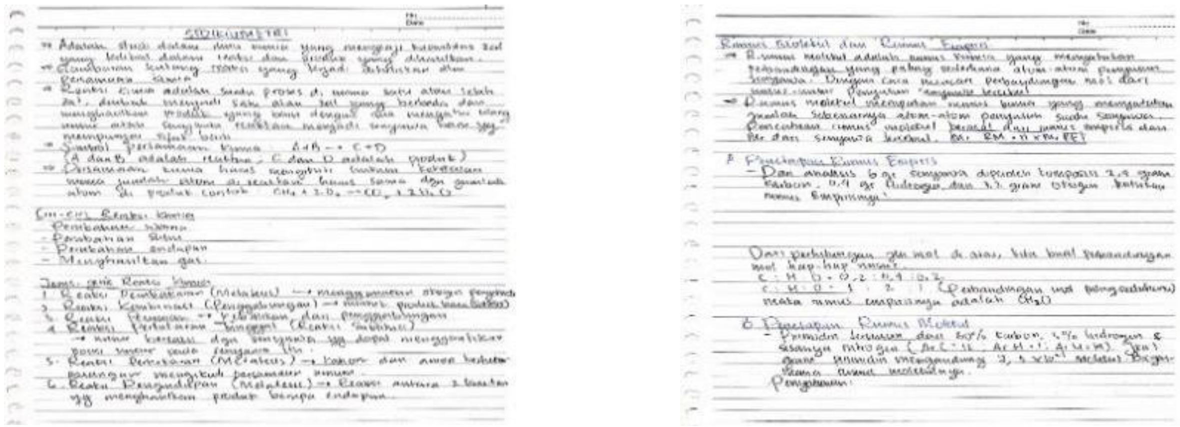

Figure 1. Samples of Student Notes during Online Lectures

After the blended learning lectures, the student SRL assessment was carried out via a questionnaire survey. The indicators assessed consist of the capability of setting goals, intelligence in determining strategies to achieve goals, and the ability to self-evaluate (Zimmerman, 2008). Students with good SRL skills can obtain maximum learning outcomes (Stoeger & Ziegler, 2005). The result of the student SRL assessment is presented in Table 4.

Table 4. The Category of Post-Lecture Student SRL

Respondent	Score	Category
M-1	88	High
M-2	75	Average
M-3	High	High
M-4	High	High
M-5	High	High
M-6	High	High
M-7	72	Average
M-8	56	Low
M-9	67	Average

Table 4 shows that 56% of students have high SRL levels, 33% have average SRL levels, and 11% have low SRL levels. Cognitive learning outcomes were assessed using quizzes, exercises, and formative tests. The affective assessment was conducted through peer observation to assess student attitudes related to discipline, cooperation skills, communication skills, and responsibility. Meanwhile, the psychomotor achievement was evaluated by assessing the electrolyte and non-electrolyte solution testing instrument. Table 5 describes the assessment result of students' cognitive, affective, and psychomotor learning outcomes.

Table 5. Assessment of Learning Achievements

Respondent	Cognitive Achievement		Affective Achievement	Psychomotor (Design Result)
	Pre-Test	Post-Test		
M-1	75	90	Excellent	Developed
M-2	40	74	Good	Underdeveloped
M-3	55	81	Excellent	Developed
M-4	64	85	Excellent	Developed
M-5	58	77	Excellent	Developed
M-6	62	84	Excellent	Developed
M-7	37	54	Average	Underdeveloped
M-8	25	61	Poor	Underdeveloped
M-9	25	71	Excellent	Developed

Table 5 shows that all students' scores increased from pre-test and post-test. Initially, students were unfamiliar with virtual lectures; however, in-person communication was carried out when students submitted assignments and quiz results. Communication via WhatsApp was also frequently carried out during lectures; therefore, the emotional bond between students and lecturers was maintained during online lectures. In-person lectures have increased motivation and SRL, increasing students' post-test scores.

Measurement of student attitudes related to discipline, cooperation skills, communication skills, and responsibility showed that 67% are excellent, 11% are good, 11% are average, and 11% are poor. Meanwhile, 67% of instrument designs are in the developed category, while 33% of the designs are underdeveloped. Figure 2 shows an instrument design example for electrolyte and non-electrolyte testing.

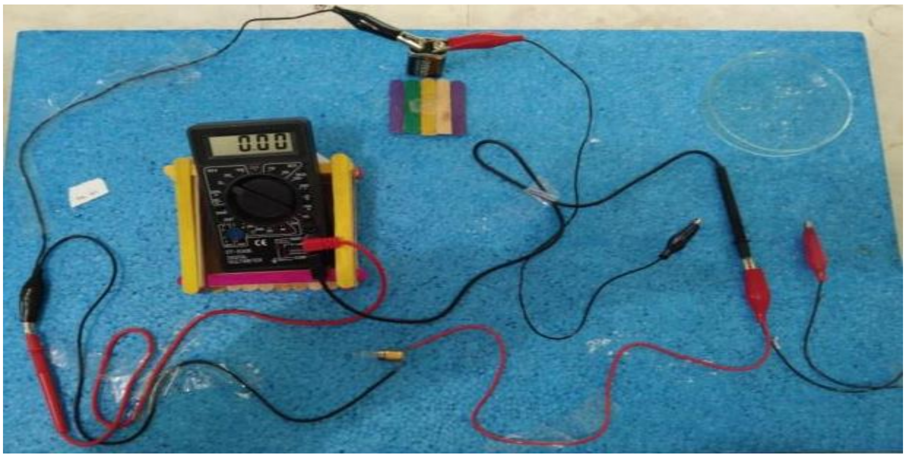

Figure 2. An Instrument for Electrolyte and Non-electrolyte Testing

Discussion

Students have positive perceptions about blended learning-PjBL lectures. The pandemic has made it impossible for students and lecturers to attend in-class lectures. The system required adjustments; thus, the learning system changed drastically. Fortunately, technology could respond to these learning challenges. However, fully online learning also has limitations, i.e., challenging for students to communicate with the lecturers and the absence of an emotional bond between lecturers and students. This situation impacted the responsibility to complete tasks. Blended learning-PjBL was able to overcome these issues.

Besides that, experimental activities in chemistry learning are essential to be carried out face-to-face in order to form a complete understanding of chemical concepts and can assess the ability of cognitive, psychomotor, and affective aspects at once. Online learning has a weakness when conducting experiments because problems with tools and materials will constrain students. Even though there is an emergency that requires no face-to-face contact at all, the experiment can be done by demonstration and recorded, and then the students watch a video demonstration of the experiment. However, this method also has weaknesses in assessing the affective and psychomotor aspects of students. Therefore, the choice of using Blended Learning lectures is a solution. So that blended learning can be maximized, it is necessary to integrate learning models that require students to learn actively, and independently. To train students to have good communication skills with colleagues and be responsible for their work.

To maximize blended learning, an important factor that must be developed is the student's SRL (Broadbent, 2017; Granberg et al., 2021). Student SRL also guarantees student success in Blended Leaning-PjBL learning (van Alten et al., 2020; Zarouk, 2020). Because the learning model is student-centered and gives students the freedom to gain knowledge from anywhere and the control of learning is in the hands of students. Problems that occur if students do not have good self-management in the learning process, they are not able to manage time, and spending time on social media will make them lag behind other friends.

The results of Self-Regulated Learning, cognitive, affective, and psychomotor achievements confirmed are directly proportional. Students who are in the high SRL category get an increase in posttest scores, their affective achievement is in the very good category, and the results of the test tool design are in the developed category. Affective achievement plays an important role in learning because it helps direct students to independent learning, i.e., managing study schedules, setting learning targets, and finding the information needed independently. In Blended Leaning-PjBL learning also builds discipline, cooperation skills, communication skills, and responsibility. It's just that in the psychomotor ability to design testing tools for electrolyte and non-electrolyte solutions, the ideal tool design has not been obtained. However, when the process of making products students is able to build a spirit of cooperation, communication skills, and responsibility for the tasks given.

Blended learning is a learning model based on constructivism theory where each individual independently builds their knowledge (Romero et al., 2013; Schunk, 2012). The availability of learning resources from the internet can maximize blended learning when combined with learning media, structured learning using modules, and practice (Zou et al., 2012). ICT-based learning is more efficient in terms of time and facilities. Time-efficient is related to the ease of accessing learning materials because the material is uploaded to the system that enables it to be accessed by students anytime and anywhere (Abdullah, 2012). Blended learning combines formal and informal learning, offline and online communication, and guided activities where independent goal achievement plays a significant role in determining learning success (Moore et al., 2011). The blended learning model relies on three pillars, i.e., traditional direct interaction between participants of the learning process, technology-mediated interaction, and independent teaching (Krasnova & Shurygin, 2019; Macdonald, 2008). Blended learning demands SRL, i.e., the ability of students to plan, organize activities independently, seek, select, and analyze information, as well as make decisions (Moore et al., 2011).

4. CONCLUSION

The limitations of online learning can be solved by combining it with in-person meetings (blended learning) and project assignments, such as making electrolyte and non-electrolyte solution testing instruments. The study indicates that students' positive perceptions of blended learning integrated with project-based learning and high SRL affected their cognitive, affective, and psychomotor achievements. Blended learning requires the lecturer's creativity to design a learning system. A bi-directional learning condition is expected if the lecturers facilitate the learning process. In addition, students are also expected to commit to each stage of the prepared learning process.

5. REFERENCES

Abdullah, M. (2012). *Students' Perception Toward the Use of Learning Management System Moodle in Teaching Translation*. Universitas Negeri Makassar.

Agustina, A., & Dian, N. (2012). Pengembangan Media Pembelajaran Video untuk Melatih Kemampuan Memecahkan Masalah pada Materi Larutan Asam Basa. *Unesa Journal of Chemistry Education*, *1*(1), 10–16. https://doi.org/10.26740/ujced.v1n1.p%25p.

Antara, I. G. W. S., Suma, K., & Parmiti, D. P. (2022). E-Scrapbook: Konstruksi Media Pembelajaran Digital Bermuatan Soal-soal Higher Order Thinking Skills. *Jurnal Edutech Undiksha*, *10*(1), 11–20. https://doi.org/10.23887/jeu.v10i1.47559.

Bell, P. A. (2001). *Enviromental Psychology*. Harcourt College Publisher.

Bi, X., & Shi, X. (2019). On the Effects of Computer-Assisted Teaching on Learning Results Based on Blended Learning Method. *International Journal of Emerging Technologies in Learning (i-JET)*, *14*(1), 58 – 70. https://doi.org/10.3991/ijet.v14i01.9458.

Broadbent, J. (2017). Comparing online and blended learner's self-regulated learning strategies and academic performance. *Internet and Higher Education*, *33*, 24–32. https://doi.org/10.1016/j.iheduc.2017.01.004.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and Procedures for Developing Grounded Theory* (3rd ed.). Sage Publications. https://doi.org/10.4135/9781452230153.

Darmaji, Kurniawan, Astalini, Winda, Heldalia, & Kartina. (2020). The Correlation Between Student Perceptions of the Use of E-Modules with Students' Basic Science Process Skills. *Jurnal Pendidikan Indonesia*, *9*(4), 719 – 729. https://doi.org/10.23887/jpi-undiksha.v9i4.28310.

Densin, & Lincoln. (2009). *Qualitative Research*. Pustaka Pelajar.

Dewi, A. A. S., Sudarma, I. K., & Tegeh, I. M. (2022). Video Pembelajaran Pada Muatan Pembelajaran IPA untuk Siswa Kelas V Sekolah Dasar. *Indonesian Journal of Instruction*, *3*(1), 1–14. https://doi.org/10.23887/iji.v3i1.31272.

Dunlosky, J., Rawson, K. A., & Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving Students' Learning with Effective Learning Techniques: Promising Directions from Cognitive and Educational Psychology. *Psychological Science in the Public Interest, Supplement*, *14*(1), 4–58. https://doi.org/10.1177/1529100612453266.

Dwiningsih, K., & Mangengke, B. B. (2021). Pembelajaran Kimia Berbasis Kooperatif Think Pair Share (TPS) Dengan Berbantuan Virtual Laboratorium Untuk Meningkatkan Hasil Belajar Siswa. *Jurnal Inovasi Pendidikan Kimia*, *15*(1), 2706–2716. https://doi.org/10.15294/jipk.v15i1.21595.

Fraenkel, J., & Wallen, N. (2006). *How to Design and Evaluate Research in Education*. McGraw-Hill.

Ginns, P., & Ellis, R. A. (2009). Evaluating the Quality of e-Learning at the Degree Level in the Student Experience of Blended Learning. *British Journal of Educational Technology*, *40*(4), 652–663. https://doi.org/10.1111/j.1467-8535.2008.00861.x.

Granberg, C., Palm, T., & Palmberg, B. (2021). A case study of a formative assessment practice and the effects on students' self-regulated learning. *Studies in Educational Evaluation*, *68*, 100955. https://doi.org/10.1016/j.stueduc.2020.100955.

Gunbatar, S. A., Celikkiran, A. T., Kutucu, E. S., & Kiran, B. E. (2018). The Influence of a Design-Based Elective STEM Course on Pre-Service Chemistry Teachers' Content Knowledge, STEM Conceptions, and Engineering Views. *Chemical Education Research Practice*, *19*, 954. https://doi.org/10.1039/C8RP00128F.

Hammond, L. D., Flook, L., Harvey, C. C., Barron, B., & Osher, D. (2019). Implications for Educational Practice of The Science of Learning and Development. *Applied Developmental Science*, 1–44. https://doi.org/10.1080/10888691.2018.1537791.

Husamah, H. (2015). Thinking Skills for Environmental Sustainability Perspective of New Students of Biology Education Department Through Blended Project Based Learning Model. *Jurnal Pendidikan IPA Indonesia*, *4*(2), 110–119. https://doi.org/10.15294/jpii.v4i2.3878.

Khoiroh, W., Aini, N., & Budhi, H. S. (2021). Analisis Kesulitan Kegiatan Praktikum Kimia Dasar Mahasiswa S1 Tadris IPA IAIN Kudus Di Masa Pandemi Covid-19. *Wahana Matematika Dan Sains*, *15*(2), 107 – 114. https://doi.org/10.23887/wms.v15i2.30678.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-Based Learning: A review of The Literature. *Improving Schools*, *19*(3), 267–277. https://doi.org/10.1177/1365480216659733.

Krasnova, L., & Shurygin, V. (2019). Blended Learning of Physics in the Context of the Professional Development of Teachers. *International Journal of Emerging Technologies in Learning (i-JET)*, *14*(23), 17–32. https://doi.org/10.3991/ijet.v14i23.11084.

Macdonald, J. (2008). *Blended Learning and Online Tutoring*. Gower Publishing Company.

Masino, S., & Zarazúa, M. N. (2016). What Works to Improve the of Student Learning in Developing Countries? *International Journal of Educational Development*, *48*, 53–65. https://doi.org/10.1016/j.ijedudev.2015.11.012.

Mcfarlane, D. A. (2013). Understanding the Challenges of Science Education in the 21st Century: New Opportunities for Scientific Literacy. *International Letters of Social and Humanistic Sciences*, *4*, 35–44. https://doi.org/10.18052/www.scipress.com/ILSHS.4.35.

Moore, J. L., Deane, C. ., & Galyen, K. (2011). E-Learning, Online learning, and Distance Learning Environments: Are They The Same? *The Internet and Higher Education*, *14*(2), 129–135. https://doi.org/10.1016/j.iheduc.2010.10.001.

Palys, T., & Atchison, C. (2014). *Research Decisions: Quantitative, Qualitative, and Mixed Methods Approaches* (5th ed.). Nelson Education.

Pedaste, M., Maeots, M., Siiman, L. A., Jong, T. D., Riesen, Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of Inquiry-Based Learning: Definitions and the Inquiry Cycle. *Educational Research Review*, *14*, 47–61. https://doi.org/10.1016/j.edurev.2015.02.003.

Phuapan, P., Viriyavejakul, C., & Pimdee, P. (2016). An Analysis of Digital Literacy Skills among Thai University Seniors. *International Journal of Emerging Technologies in Learning*, *11*(3), 24–31. https://doi.org/10.3991/ijet.v11i03.5301.

Prabha, S. (2016). Laboratory Experiences for Prospective Science Teachers: A Meta-analytic Review of Issues and Concerns. *European Scientific Journal*, *12*(34), 235–250. https://doi.org/10.19044/esj.2016.v12n34p235.

Pradita, K. K., Mahadewi, L. P. P., & Sukmana, A. I. W. I. Y. (2022). Konten E-Learning dalam Pembelajaran Bahasa Bali pada Era Revolusi Industri 4.0. *Indonesian Journal of Instruction*, *3*(1), 25–33. https://doi.org/10.23887/iji.v3i1.31134.

Rahardjanto, A., Husamah, & Fauzi, A. (2019). Hybrid-PjBL: Learning Outcomes, Creative Thinking Skills, and Learning Motivation of Preservice Teacher. *International Conference on Mathematics and Science Education*, *12*(2), 179–192. https://doi.org/10.1088/1742-6596/1521/3/032072.

Romero, C., Espejo, P. G., Zafra, A., Romero, J. R., & Ventura, S. (2013). Web Usage Mining for Predicting Final Marks of Students that Use Moodle Courses. *Computer Applications in Engineering Education*, *21*(1), 135–146. https://doi.org/10.1002/cae.20456.

Schunk, D. H. (2012). *Learning Theories an Education Perspective* (6th ed.). Pustaka Pelajar.

Shidiq, A. S., Yamtinah, S., & Masykuri, M. (2019). Identifying and addressing students' learning difficulties in hydrolysis using testlet instrument. *AIP Conference Proceedings*, *2194*(1), 020117. https://doi.org/10.1063/1.5139849.

Stoeger, H., & Ziegler, A. (2005). Evaluation of an Elementary Classroom Self-Regulated Learning Program for Gifted Mathematics Underachievers. *International Education Journal*, *6*(2), 261–271. https://files.eric.ed.gov/fulltext/EJ854979.pdf.

Subekti, H., Taufiq, M., Susilo, H., Ibrohim, I., & Suwono, H. (2018). Mengembangkan Literasi Informasi Melalui Belajar Berbasis Kehidupan Terintegrasi STEM Untuk Menyiapkan Calon Guru Sains Dalam Menghadapi Era Revolusi Industri 4.0: Review Literatur. *Education and Human Development Journal*, *3*(1), 81–90. https://doi.org/10.33086/ehdj.v3i1.90.

van Alten, D. C. D., Phielix, C., Janssen, J., & Kester, L. (2020). Self-regulated learning support in flipped learning videos enhances learning outcomes. *Computers and Education*, *158*(July), 104000. https://doi.org/10.1016/j.compedu.2020.104000.

Yustina, Syafii, W., & Vebrianto, R. (2020). The Effects of Blended Learning and Project-Based Learning on Pre-Service Biology Teachers' Creative Thinking Through Online Learning In The Covid-19 Pandemic. *Jurnal Pendidikan IPA Indonesia*, *9*(3), 408–420. https://doi.org/10.15294/jpii.v9i3.24706.

Zarouk, M. Y. (2020). The Impact of Flipped Project-Based Learning on Self-Regulation in Higher Education. *International Journal of Emerging Technologies in Learning (i-JET)*, *15*(17), 127 – 147. https://www.learntechlib.org/p/218014/.

Zimmerman, B. J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal*, *45*(1), 166–183. https://doi.org/10.3102/0002831207312909.

Zou, J., Liu, Q., & Yang, Z. (2012). Development of a Moodle Course for School Children's Table Tennis Learning Based on Competence Motivation Theory, Its Effectiveness in Comparison to Traditional Training Method. *Computers & Education*, *59*(2), 294–303. https://doi.org/10.1016/j.compedu.2012.01.008.

Zubaidah, S., Fuad, N. M., Mahanal, S., & Suarsini, E. (2017). Improving Creative Thinking Ability of Students Through Differentiated Science Inquiry Integrated with Mind Map. *Journal of Turkish Science Education*, *14*(4), 77–91. https://doi.org/10.12973/tused.10214a.