

The impact of project-based E-learning on cognitive and psychomotor learning achievement in sports massage courses

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Abstract

The purpose of this study was to describe the effects of a project-based e-learning (PjB-eL) model on cognitive and psychomotor learning achievement in sports massage courses. This quasi-experimental study used a post-test-only non-equivalent control group design. The research sample consisted of 2 classes of 40 people each, selected by a simple random sampling technique, with one class each as the experimental and control groups. Data on cognitive learning outcomes were collected using tests, and psychomotor learning outcomes using project observation sheets. The test used has met all the valid and reliable criteria. Data analysis was performed using descriptive statistics and multivariate analysis of variance test. The results showed that the average cognitive and psychomotor learning outcomes in the experimental group were significantly higher than those in the control group. The PjB-eL model can be recommended as an effective learning model to improve learning outcomes.

Keywords: Project-based, e-learning, cognitive, psychomotor, learning achievement.

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1. Introduction

Education in the 21st century has led to a significant shift in literacy. The use of digital tools, digital platforms, technological inventions and information technology structures is no longer an option but a necessity (Mustafa & Dwiyoogo, 2020). The development of information technology is currently reaching all areas of people's lives, including education. Educational technology in education is very large, not only in the design position but also in the positions of development, application, learning operation and assessment (Syafriafdi, 2020). According to Seels (1995), there are five disciplines of educational technology, Videlicet design, development, application operation, management and assessment. The learning technology approach will improve the quality of education.

Learning achievement is a result of the literacy process (Sudarmika et al., 2020). Learning achievement is also expressed as the position of scholars' success in achieving the pretensions set in a tutoring programme (Syah, 2017). The results of a preliminary study on sports massage learning achievement in the 2019/2020 academic year showed a chance of data on the results of the score C = 5%, the value B negative = 7%, the value B positive = 10%, the score A negative = 65% and the value A positive = 3%. This result is relatively low due to several factors, including 1) the strategy for delivering literacy is not optimal; and 2) scholars come from diverse backgrounds, capacities and different learning styles so they cannot have the same academic capability. The results of compliance and interviews with lecturers showed that sports massage learning still uses direct instruction learning (DI) combined with certain platforms but tends to be centred on the lecturer as the main resource (teacher-centred); the lecturer only uses the lecture system supported by PowerPoint presentation media and also gives tests to students. The lecturer should prepare tutoring content for students in such a way as to maximise meaningful literacy. Content understanding not only requires understanding crucial literacy generalities but also the conformation of meaningful links to bring these generalities into concinnity with knowledge (Stanković et al., 2018).

Advanced education in the 21st century requires lecturers and scholars to form a student-centred literacy terrain (Fadhilatunisa et al., 2020). Learning that is applied to scholars should be suitable to ameliorate learning achievement, especially when learning conditioning is affected by the coronavirus disease 2019 (COVID-19) epidemic so that literacy is carried out at home (Suartama et al., 2022). This comes after letters from the Secretary General of the Minister of Education and Culture with number 35492/A. A 5/HK/2020 dated 12 March 2020, and 3 March 2020, from the Republic of Indonesia's Minister of Education and Culture regarding the prevention of COVID-19 in educational settings. Regarding the impact of this epidemic, the literacy process has adapted to changes so that the literacy system is integrated through the Internet network to address this problem. One of the snags is a result of problems faced in online literacy. For online literacy to be meaningful, it must have the right kind of learning strategy community. One is enforcing design project-based learning (PjBL) that is combined online (Yunus et al., 2022). Abidin also explained that through project-based online learning, students can have meaningful learning so that the knowledge they hold can be used as a provision to solve problems. PjBL is a learning model that is suitable for learning from home because students are invited to unite, be independent, explore and use assessments that are adapted to their conditions (Yuliana, 2020).

The PjBL model is a methodical tutoring model that involves students learning knowledge and skills through a structured process and real experience and is strictly designed to produce products (Buck Institute for Education, 2019). The stages of the PjBL model begin with conditioning concentrated on questions or problems, designing the stages of design completion, collecting and analysing data,

collecting reports and communicating the results of project activities (Tamim & Grant, 2013). According to Craft and Capraro (2017), PjBL is a learning model that places students as builders of the knowledge they have grounded in the knowledge they already have. As a result, students become active learners. Learners have high academic involvement in their literacy with PjBL models because they are surrounded with interesting, challenging projects, related to the phenomena of their daily lives and applicable to life in society. Exploration of the use of PjBL in improving learning achievement has been carried out by Cahyaningsih et al. (2020), who found that the PjBL model supported by multimedia PowerPoint is effective for student learning outcomes.

The results of Salehudin's (2020) exploration examined the effect of PjBL supported by e-learning on learning outcomes and found that the findings of PjBL assisted by e-learning affected learning outcomes for understanding concepts. Yao et al. (2019) found that PjBL has a positive impact on student learning procedures and increases student learning outcomes in China. According to Qholby and Lazulva (2020), the effect of implementing the project-based e-learning (PjB-eL) model through Undiksha's e-learning on student learning outcomes and the response rate material and concluded that the PjBL model supported by Google Classroom provides better scores in the cognitive domain than the PjBL model that does not use e-learning media. Likewise, the results of the exploration by Santyasa et al. (2020) show that students who study with PjBL have higher learning achievements than those who study with DI. As shown in research findings, the PjBL model is anticipated to optimise student learning outcomes in sports massage learning. Sugiarto et al.'s (2020) research found that interactive multimedia-based sports massage learning can improve learning achievement for students of physical education, health and recreation. This is reinforced by Sudarma et al. (2022), who state that the use of various learning resources is an effort to solve learning problems.

Based on this background of the problem, several problems can be formulated. Is there any effect of the learning model on cognitive learning achievement and psychomotor learning achievement between groups of students who study with PjB-eL and between groups of students who study direct e-learning (DeL)?

1.1. Conceptual or theoretical framework

The characteristics of sports massage can be described as a soft tissue treatment, primarily aimed at athletes to relieve muscle tension and minor injuries caused as a result of exercise. Sports massage is substantially used as part of an athlete's training programme, completing progressive training and minimising the eventuality of injury incidents by reducing muscle pressure. It can be used in a variety of situations; pre-event, which is usually used to physically prepare the athlete and help mental preparation; inter or intra-event, which helps prepare muscles for the next activity; and post-event, which can help relax after activity and can be used to assess muscle condition for implicit injury. Sports massage therapists work with medical and healthcare teams in sports surroundings (Complementary & Natural Healthcare Council, 2020).

E-learning is a technique that allows users to advance through a large number of tools, like Videlicet particularly, computers, notebooks, mobile phones, laptops, tablets and others (Ali et al., 2018; Parwati & Suharta, 2020). E-learning uses technology that involves information, communication and the Internet with various operations, similar to web-based learning, computer-based learning, virtual classrooms and digital collaboration (da Silva & de Souza, 2017). Some of the benefits of e-learning for learners include saving on learning; real-time live broadcasts of programmes, ideas and generalities; and ensuring that courses are kept up-to-date and required (Suartama et al., 2021). But diverse expenses related to network hardware such as servers, storage devices etc. need to develop an e-learning platform which

requires high costs. In addition, another big problem in this regard is the shortage in platform design and operation staff (Hussein & Hilmi, 2020; Zhang & Zhu, 2017).

Learning competency is a critical metacognitive phenomenon that develops during active learning activities and varies depending on the motivational orientation of students. Students detail their cognitive needs, raise their general cognitive activity and increase their selectivity in information acquisition strategies while at university. The process of building learning capacities begins with the experience of diverse learning activities and the resulting changes in the cognitive domain (Grokhol'skiy et al., 2020). Cognitive learning accomplishments are a specific level of academic aptitude gained through standardised exam results (Tuaputty et al., 2021). The information is then used to determine whether the student will graduate, fail or receive a grade-level promotion, which will be valuable when applying for jobs or entering the next level of study (Mathew, 2017). Munawaroh's (2017) study focuses on measurable increases in student academic achievement. To put it another way, it evaluates the measurable outcomes of students' intellectual efforts in a variety of educational activities that occur as a result of the teaching and learning process.

Massage is a reflexology technique that tries to influence the nerve system, muscles (Popa & Dobrescu, 2017) and lymphatic system locally or more broadly. Massage is done with the hands, particularly on the muscles of the body, and it can boost blood circulation (Radziejowska et al., 2020) and assist in releasing bodily fluids if done properly by rubbing, stroking and striking the skin and muscles (Sulistyorini et al., 2020). Sports massage plays a vital role in enhancing and sustaining one's performance. Massage is the practice of using hand movements to relieve pain and preserve physical wellness. The recipient will experience a sensation of serenity and relaxation as a result of the mechanical hand movements. Many issues will arise if massage is taught in writing without prior practice. Massage is a hand skill or manipulation skill that requires both practical experience and theoretical knowledge. If you undertake practical exercises on your own but are still under the supervision of a teacher or massage specialist, you will master massage techniques (Suprayitno et al., 2021). Sports massage is used to help athletes perform, relieve fatigue and recuperate before and after activities (García-Sillero et al., 2021).

1.2. Related research

Hizbullah et al. (2018) found a difference in learning outcomes between PjBL models and traditional learning models for students, indicating that PjBL is more successful than traditional learning models for enhancing animation technique learning outcomes. Because PjBL models can boost students' creative and social skills while they learn, the teacher's involvement is critical in implementing and developing learning models that can boost students' creativity and social skills while they learn, making the learning process more meaningful (Taufiqurrahman et al., 2021).

Cognitive learning achievements can be related to collaboration skills (Hidayati et al., 2020). There is social interaction between students in the group during the collaboration. This encourages the development of conceptual knowledge since students in groups try to comprehend and understand other group members (Suastika et al., 2022), resulting in the construction of knowledge sharing (Le et al., 2018). According to research, students who actively participate in group work complete projects more quickly than students who work alone (Elgort et al., 2008). Other studies show that students who collaborate can better articulate their thoughts and improve their learning results (Kramarski & Mevarech, 2015; Kuhn & Dean, 2004). Lack of collaborative abilities, on the other hand, hinders student performance in groups and has an impact on learning outcomes (Popov et al., 2012).

1.3. Purpose of the study

The purpose of this study was to analyse differences in cognitive learning achievement and psychomotor learning achievement between groups of students who studied PjB-eL and between groups of students who studied DI e-learning (DI-eL).

2. Research methodology

2.1. Research design

This study used a quasi-experimental research with non-equivalent post-test-only control-group design. Experiments were carried out to find the effect of PjB-eL on cognitive and psychomotor learning achievement in sports massage course. The research was conducted for 4 months, which began with the preparation and sharing of perceptions with the lecturer, conducting experiments and making reports on the results of research with the lecturer.

2.2. Research population and sample

The population of this research is all sports and health students who take massage courses that are distributed into four classes, namely classes A, B, C and D, who have the same academic ability. Eighty students were involved who were sampled using a total sampling technique. Two classes were given learning treatment with a PjB-eL model and two others were treated as controls.

2.3. Data collection technique and research instrument

The data collected were cognitive learning achievement test scores and psychomotor scores obtained from observations. The test instrument and observation sheet were validated by two experts and the reliability validity test has been carried out. The expert test results obtained a 0.94 in the very valid category. Cognitive learning achievement data in the form of expanded multiple choice consisted of 20 items, and only 15 items were declared valid and reliable. Psychomotor learning and achievement data were collected with skill test observation sheets in the form of videos showing sports massage. The assessment on the student project observation sheet is based on the ability to perform the stages of sports massage, namely effleurage, petrissage, friction and shaking.

2.4. Procedures

The researcher conducted a direct study on two classes appointed as experimental classes and two other classes as control classes. In the experimental classes, the researcher carried out learning activities using PjB-eL, whereas the control classes had their learning activities carried out by using the DeL learning model.

PjB-eL is taught as aligned with the course subject at that time, i.e., sports massage course. Here, the role of the researcher was only as a facilitator. The students were to search for their own knowledge according to the guide and strategies of PjB-eL. Learning activities consisted of:

- (1) determining basic questions;
- (2) designing project plans;
- (3) developing schedules;
- (4) monitoring project progress;
- (5) testing results;

(6) evaluating experiences.

Learning activities that are not limited in space and time were done through e-learning portals available on <https://elearning.undiksha.ac.id>, including (1) accessing lecture material (books, files, doc, pdf, ppt, jpg, png, swf, exe), page, URL and labels; (2) completing assignments (online text and file submission); (3) discussion (forum); (4) reading assessment (lesson/feedback); and (5) presentation of material (web conference/Zoom meeting).

For the control class, the learning activities were implemented using a DeL learning model. Through this model, students could obtain main course materials and enrichment materials, access assignments, and send answers to the lecturer as has always been done so far. The materials and topics were the same in both classes, focusing on the sports massage course. The researcher managed a test for cognitive learning achievement and psychomotor learning achievement data were collected with skill test observation sheets in the form of videos doing sports massage at the end of the study to investigate the level of success of the model used in the study.

2.5. Data analysis technique

Hypothesis testing was carried out by determining the analysis requirements, namely the normality test of the data distribution, the homogeneity of variance test, the overall variance-covariance homogeneity test and the collinearity test. The normality test for data distribution uses Shapiro–Wilk’s test, while the homogeneity of variance test uses the Levene test; the variance-covariance homogeneity test uses Box’s test; and the collinearity test uses the product-moment correlation. Furthermore, the data were analysed descriptively and using Multivariate Analysis of Variance (MANOVA). All hypothesis testing was carried out at a significance level of 0.05 and with the help of the Statistical Package for the Social Sciences 25.0 for the Windows programme.

3. Results

3.1. Description data of the result of students’ sport massage cognitive and psychomotor learning achievements

The PjB-eL model was applied to the experimental group while the DeL learning model was applied to the control group. After the implementation of the two learning models in each group, posts were made to determine the effect of the two learning models on students' cognitive and psychomotor learning achievements. A recapitulation of the results of the descriptive analysis of students' cognitive and psychomotor learning achievement values based on the learning model is presented in Table 1.

Table 1. Results of Students’ Sport Massage Cognitive and Psychomotor Learning Achievements

| Descriptive data | PjB-eL | | DI-eL | |
|------------------|---|---|---|---|
| | Cognitive learning achievement (n = 40) | Psychomotor learning achievement (n = 40) | Cognitive learning achievement (n = 40) | Psychomotor learning achievement (n = 40) |
| Mean | 72.30 | 81.38 | 63.58 | 76.38 |
| Median | 72.00 | 80.00 | 63.00 | 75.00 |
| Std. deviation | 6.501 | 7.678 | 6.453 | 8.005 |

| | | | | |
|----------|--------|--------|--------|--------|
| Variance | 42.267 | 58.958 | 41.635 | 64.087 |
| Minimum | 62 | 65 | 53 | 60 |
| Maximum | 87 | 95 | 77 | 90 |

Table 1 shows the cognitive massage learning outcomes of students who study using the PjB-eL model, which is obtained by an average of 72.30. This average is higher than students who studied with the DI-eL model, with an average of 63.58. The psychomotor learning outcomes of students who study using the PjB-eL model were obtained, with an average of 81.38, which is higher than those who studied with the DI-eL learning model, with an average of 76.38.

3.2. Results of the analysis prerequisite test

Furthermore, to determine the effect of the learning model on cognitive and psychomotor learning outcomes, the MANOVA test was carried out by performing a normality test of data distribution, homogeneity test of variance between groups and variance-covariance matrix test. The results are presented in Table 2-4.

Table 2. Normality Test of Student Cognitive and Psychomotor Learning Achievements

| Variable | E-learning model | Kolmogorov–Smirnova | | | Shapiro–Wilk | | |
|----------------------------------|------------------|---------------------|----|--------|--------------|----|-------|
| | | Statistic | df | Sig. | Statistic | df | Sig. |
| Cognitive learning achievement | PjB-eL | 0.114 | 40 | 0.200* | 0.957 | 40 | 0.137 |
| | DI-eL | 0.136 | 40 | 0.062 | 0.964 | 40 | 0.221 |
| Psychomotor learning achievement | PjB-eL | 0.132 | 40 | 0.079 | 0.953 | 40 | 0.093 |
| | DI-eL | 0.132 | 40 | 0.078 | 0.952 | 40 | 0.087 |

Table 2 shows the results of the normality test of students' cognitive and psychomotor learning achievement data obtained with a p-value > 0.05, and so the cognitive and psychomotor learning achievement data are normally distributed.

Table 3. Results of Homogeneity Test Variants of Cognitive and Psychomotor Learning Achievement

| | | Levene's statistic | df1 | df2 | Sig. |
|----------------------------------|--------------------------------------|--------------------|-----|--------|-------|
| Cognitive learning achievement | Based on mean | 0.005 | 1 | 78 | 0.944 |
| | Based on median | 0.001 | 1 | 78 | 0.978 |
| | Based on median and with adjusted df | 0.001 | 1 | 77.999 | 0.978 |
| | Based on trimmed mean | 0.004 | 1 | 78 | 0.949 |
| Psychomotor learning achievement | Based on mean | 0.064 | 1 | 78 | 0.802 |
| | Based on median | 0.053 | 1 | 78 | 0.818 |
| | Based on median and with adjusted df | 0.053 | 1 | 77.868 | 0.818 |
| | Based on trimmed mean | 0.071 | 1 | 78 | 0.790 |

Table 3 shows the learning and psychomotor achievement data obtained with $p > 0.05$, and so the variance between groups of learning models is homogeneous. The results of the homogeneity of the variance matrix can be seen in Table 4.

Table 4. Results of Homogeneity Matrix Variance/Covariance

| | |
|---------|---------------|
| Box's M | 0.460 |
| F | 0.149 |
| df1 | 3 |
| df2 | 1,095,120.000 |
| Sig. | 0.930 |

Table 4 shows the variance matrix with the value of $F = 0.149$ and $p > 0.05$; thus, the variance matrix between cognitive learning outcomes and student psychomotor learning outcomes is homogeneous.

3.3. Description of the calculation results by the use of the MANOVA technique

The results of the assumption test carried out have met all the criteria for the MANOVA test, and thus the MANOVA test can be continued. The recapitulation of the MANOVA test results is presented in Tables 5 and 6.

Table 5. The Effect of Learning Models on Cognitive and Psychomotor Learning Achievement in Sports Massage Courses

| | Effect | Value | F | Hypothesis df | Error df | Sig. |
|------------------|--------------------|---------|------------|---------------|----------|-------|
| Intercept | Pillai's Trace | 0.994 | 6,242.904a | 2.000 | 77.000 | 0.000 |
| | Wilks' Lambda | 0.006 | 6,242.904a | 2.000 | 77.000 | 0.000 |
| | Hotelling's Trace | 162.153 | 6,242.904a | 2.000 | 77.000 | 0.000 |
| | Roy's Largest Root | 162.153 | 6,242.904a | 2.000 | 77.000 | 0.000 |
| e-Learning model | Pillai's Trace | 0.322 | 18.293a | 2.000 | 77.000 | 0.000 |
| | Wilks' Lambda | 0.678 | 18.293a | 2.000 | 77.000 | 0.000 |
| | Hotelling's Trace | 0.475 | 18.293a | 2.000 | 77.000 | 0.000 |
| | Roy's Largest Root | 0.475 | 18.293a | 2.000 | 77.000 | 0.000 |

Table 5 shows Pillai's trace values, Wilks' Lambda, Hotelling's trace and Roy's largest root were obtained with $F = 18.293$ and $p < 0.05$; thus, there was an effect of the learning model on cognitive and psychomotor learning achievement in sports massage courses.

Table 6. The Result of MANOVA

| Source | Dependent variable | Type III sum of | | | | |
|------------------|----------------------------------|-----------------|----|-------------|-----------|-------|
| | | squares | df | Mean square | F | Sig. |
| Corrected model | Cognitive learning achievement | 1,522.512a | 1 | 1,522.512 | 36.293 | 0.000 |
| | Psychomotor learning achievement | 500.000b | 1 | 500.000 | 8.127 | 0.006 |
| Intercept | Cognitive learning achievement | 369,240.313 | 1 | 369,240.313 | 8,801.713 | 0.000 |
| | Psychomotor learning achievement | 497,701.250 | 1 | 497,701.250 | 8,089.752 | 0.000 |
| e-Learning model | Cognitive learning achievement | 1,522.513 | 1 | 1,522.513 | 36.293 | 0.000 |
| | Psychomotor learning achievement | 500.000 | 1 | 500.000 | 8.127 | 0.006 |

| | | | | |
|-----------------|----------------------------------|-------------|----|--------|
| Error | Cognitive learning achievement | 3,272.175 | 78 | 41.951 |
| | Psychomotor learning achievement | 4,798.750 | 78 | 61.522 |
| Total | Cognitive learning achievement | 374,035.000 | 80 | |
| | Psychomotor learning achievement | 503,000.000 | 80 | |
| Corrected total | Cognitive learning achievement | 4,794.687 | 79 | |
| | Psychomotor learning achievement | 5,298.750 | 79 | |

Table 6 shows the effect of the learning model on cognitive learning achievement obtained with an F-value of 36.293 and a p-value of 0.000; thus, it can be concluded that there is an influence of the learning model on cognitive learning achievement. The effect of the learning model on psychomotor learning achievement is obtained by $F = 8.127$ and $p\text{-value} = 0.006$; thus, it can be concluded that there is an influence of the learning model on psychomotor learning achievement.

4. Discussions

4.1. The effect of learning models on achieving student cognitive and psychomotor learning achievements

The average value of cognitive learning achievement of sports massage students in the PjB-eL group is higher than in the DI-eL group, according to descriptive statistics. The learning achievement of psychomotor sports massage was shown to be higher than DI-eL in descriptive data (Table 1). The multivariate analysis revealed that the learning model affected cognitive and psychomotor learning achievement in sports massage courses, with a value of $F = 18.293$ and $p = 0.05$ (Table 5). The findings of this study are supported by Sumarni et al. (2016), who found that learning using work projects in the form of student-centred teaching aids is crucial and useful for students' cognitive, emotional and psychomotor development. Work practice helps students grasp lessons, apply what they have learned and improve their psychomotor abilities and dexterity by allowing them to integrate what they have learned in real-life situations. Observing, measuring, classifying, recording data, developing hypotheses, using data, creating, changing, controlling variables and conducting scientific experiments are just a few of the skills that may be learned through these activities (Sumarni et al., 2016). Cognitive learning successes pertain to a person's intellectual abilities. Students' affective and psychomotor abilities are inextricably linked to their ability to learn cognitively. This is because cognitive, emotional and psychomotor domains are all linked to learning behaviour (Sanjaya et al., 2022). Students can strengthen their affective and psychomotor domains by achieving high cognitive learning achievement (Galloway & Bretz, 2015).

Bloom's taxonomy was created to encourage educators to focus on three domains: the cognitive domain, the psychomotor domain and the affective domain. There are numerous degrees of learning within each domain, which range from more basic, surface-level learning to more complicated and deeper learning. Depending on (1) the nature of the event, (2) the developmental level of the participating students and (3) the duration and intensity of the experience, the amount of learning will vary (Kasilingam et al., 2014). Learning to use sports massage-based instructional materials on Android makes it easier to comprehend the material's content. Students can easily access materials both on and off-campus at any time (Efendy et al., 2022).

4.2. The effect of learning models on achieving students' cognitive learning achievement

The findings revealed significant differences in cognitive learning achievement between students who studied using the PjB-eL model and students who studied using the DeL learning model ($F = 36.293$ with $p < 0.05$). The average value of cognitive learning achievement for the PjB-eL class is 72.30 (SD:

6.501), while the DI-eL class has an average value of 63.58 (SD: 6.453), according to descriptive statistics. PjB-eL, which is developed to enhance and increase student cognitive learning achievement, was found to be more effective than DI-eL in this study. The outcomes of this study support prior research which found significant disparities in academic accomplishment between pupils studying with the PjBL and DI models (Santayasa et al., 2020). Students who study using the PjBL paradigm achieve higher academic accomplishments. Students who studied using the PjB-eL model and DI-eL showed disparities in critical thinking abilities and learning achievement (Santayasa et al., 2021), whereas students who studied using the PjB-eL model showed better outcomes. According to Salehudin's (2020) research, the e-learning-assisted PBL paradigm had an impact on the learning outcomes of understanding concepts. The conclusion of this investigation corroborates previous studies. When compared to traditional learning models, PjBL models with online evaluations produce higher results (Nuryati et al., 2020).

The correlation between the findings of this study and current theories is strong enough to support the superiority of the PjB-eL model over DeL in terms of student cognitive learning achievement. Butler (2020) presents a different claim, claiming that kids with low incomes are more likely to fail in school and face major issues later in life if they do not improve their academic performance, thus teachers must help them by using the direct learning model. The direct learning technique can also help to prevent social and behavioural issues; hence, it is optimal for most pupils to be taught this way. Because of its benefits for academic achievement and student well-being, direct learning is possible in the classroom (Butler, 2020). Students' creativity, internal motivation and interest, responsibility, interpersonal communication skills, social skills, cooperation and problem-solving ability can all benefit from PjBL. Furthermore, students who participate in PjBL are assigned authentic tasks to help them create concepts that have been taught and how these concepts apply to the real world (Shin, 2018).

PjBL techniques can help students understand concepts more deeply and boost their creativity than typical classroom-based learning. Students improve creativity after using PjBL by demonstrating creative ideas, making their best efforts to create new ideas for project quality, and students are completely engaged throughout the learning process (Astawa et al., 2017). A project's scope of work, resources and planning activities are used to execute and manage resources to achieve the targeted outcomes. Understanding the scope of work, mimicking real-world challenges, improving interpersonal skills, developing concepts and creativity, evaluating actual knowledge, choosing real-world situations and testing student skills are all things that may be done in PjBL (Bhagi, 2021). PjBL, which is based on e-media tactics, helps improve students' scientific skills and motivation to learn (Safaruddin et al., 2020).

Project-based evaluations necessitate close supervision with authentic assessments (Divayana et al., 2021) and a methodical gathering of student work. The evaluation is carried out using social media to track the progress of the project (Yuliana, 2020). PjBL allows students to explore concepts in greater detail and can help them achieve better learning results (Suryani et al., 2021). The learning process will benefit from interactions between students and teachers, students and other students and students and learning materials (Syakur & Musyarofah, 2019).

4.3. The effect of learning models on achieving psychomotor learning achievements

The average value of psychomotor learning achievement for the PjB-eL class was 81.38 (SD: 7.678), whereas the average score for the DI-eL class was 76.38. (SD: 8.005). Multivariate analysis revealed that the learning model had a statistically significant effect on psychomotor learning achievement (F: 8.127 and p-value < 0.05). In this study, the PjB-eL emphasises the responsibility of the group to master and teach the material that he has learned with his other group of friends so that each student has a responsibility to ensure that each group understands the material as a whole, whereas the DI-eL

emphasises the responsibility of the individual to understand and complete a task. Physical movement behaviour and coordination, motor skills and physical abilities are all part of the psychomotor component (Sari et al., 2020). In this study, pupils' psychomotor abilities were measured through projects. The project evaluation is tailored to the various stages of sports massage activities. Effleurage, or mild and soothing rubbing and movements used at the beginning and finish of the massage, is the first stage. This technique is done with the palms of the hands and fingers together to disperse oil and warm the muscles so they may relax. The second stage is petrissage (squeezing), which is massage or squeezing movements performed on fatty and dense muscle tissue parts of the body using the palms of the hands or fingers. A grinding technique using the thumb (the strongest finger), fist, palm base or elbow is the third stage of friction. Hyperaemia, swelling of muscle fibres from blood vessels, hormonal and nerve reflexes and good for post-traumatic (tissue) regeneration schemes will minimise muscular discomfort and are the goals of this treatment. Shaking manipulation is the fourth stage, and it is the most effective in boosting blood circulation, particularly in the dispersion of food essence into the tissues (Suprayitno et al., 2021).

PjBL can improve students' psychomotor abilities because in the PjBL model students are invited to use all their kinaesthetic abilities in the learning process. Students' capacity to perform reflex movements, fundamental movements, perception, complicated skill movements and expressive movements are all psychomotor learning outcomes (Fajarwati et al., 2017). The PjBL paradigm can help students in the skilled and highly skilled categories enhance their psychomotor abilities, growing from 34.3% in cycle I to 80% in cycle II (Arpan & Bibi, 2018). In DI-eL, the teaching and learning process is more focused on the transfer of information or knowledge from lecturers to students. This notion is similar to the lecture learning model, in which lecturers provide practically all of the information to students. Learning is defined by lecturers as the collection or memorisation of facts delivered in the form of information or subject matter (Sudarmika et al., 2020). DI is based on teacher-centred DI; nevertheless, instructional approaches that do not allow for instructor assistance are unsuccessful and harmful to at-risk pupils (Butler, 2020). Students' psychomotor development must be connected with their cognitive and affective components, which necessitates clarity in planning, goals and implementation (Sari et al., 2020).

Although the PjB-eL paradigm has a favourable impact on students' cognitive and psychomotor learning accomplishments, some obstacles can stymie this process: 1) students must still adjust to the new model that is being taught. Students are already familiar with traditional models. Students are not used to studying with the new model because the teaching and learning process is quite brief and is carried out online due to the COVID-19 pandemic; 2) students have a limited internet quota, so the learning process cannot run according to normal time when face to face; and 3) other variables that have not been tightly controlled by researchers and may influence students' cognitive and psychomotor learning achievements. The limitation of this study is that we did not analyse the results of the pre-test on the multivariate test. The results of the pre-test can be used as a covariate that affects the final result. This research was also only conducted at one institution. Future research needs to pay attention to the characteristics of different subjects.

5. Conclusion

The study's findings and discussion suggest that the PjB-eL model affects cognitive and psychomotor learning achievement. The PjB-eL model class has better cognitive and psychomotor learning results than the DI-eL model class. The PjB-eL model influences cognitive learning achievement, while the use of the PjB-eL model has a significant effect on psychomotor learning achievement. Understanding the

scope of work, simulating real-world problems, improving interpersonal skills, developing concepts and creativity, interactions between students and teachers, students and other students and students and learning materials are all benefits to the learning process in PjB-eL models. The PjB-eL model was recommended as one of the solutions and tactics for improving cognitive and psychomotor learning outcomes, particularly in the post-COVID-19 epidemic. More study may be done by testing the model on subjects other than sports massage, and other elements that affect student cognitive and psychomotor learning accomplishment must be considered.

6. Suggestions

For sports science lecturers, it is necessary to consider the use of a PjB-eL model as an alternative strategy in learning sports science. Therefore, lecturers need to learn to be able to design, develop and manage this learning strategy by optimising the stages and principles of the PjB-eL model. For further research, the application of this learning model can be reused for other courses that have the same characteristics. Further research needs to examine the relationship between the PjB-eL model with other more interesting aspects, such as learning efficiency and learning attractiveness.

References

- Ali, M., Hossain, S. M. K., & Ahmed, T. (2018). Effectiveness of E-learning for university students : Evidence from. *Asian Journal of Empirical Research*, 8(10), 352–360. <https://doi.org/10.18488/journal.1007/2018.8.10/1007.10.352.360>
- Arpan, M., & Bibi, S. (2018). Penerapan Model Pembelajaran Project Based Learning terhadap Kemampuan. *Revolusi Mental Mewujudkan Tenaga Pendidikan Yang Profesional Dalam Menyiapkan Generasi Emas Indonesia*, 3, 1–36.
- Astawa, N. L. P. N. S. P., Artini, L. P., & Nitiasih, P. K. (2017). Project-based learning activities and efl students' productive skills in english. *Journal of Language Teaching and Research*, 8(6), 1147–1155. <https://doi.org/10.17507/jltr.0806.16>
- Bhagi, U. (2021). 12 reasons why project-based learning is better than traditional classroom learning. *ELearning Industry. Dernière Mise à Jour*, 19, 1–9.
- Buck Institute for Education. (2019). Project Based Learning. Buck Institute for Education
- Butler, K. (2020). The Value of Direct Instruction for At-Risk Students. *Journal of Education and Development*, 4(2), 10–16. <https://doi.org/10.20849/jed.v4i2.741>
- Cahyaningsih, R. N., Siswanto, J., & Sukamto. (2020). Keefektifan Model Project Based Learning Berbantu Multimedia Power Point Terhadap Hasil Belajar IPA. *Jurnal Penelitian Dan Pengembangan Pendidikan*, 4(1), 34–40. <https://doi.org/10.23887/jppp.v4i1.25014>
- Complementary & Natural Healthcare Council. (2020). Core Curriculum for Sports Massage. In *The Complementary & Natural Healthcare Council*.
- Craft, A. M., & Capraro, R. M. (2017). Science, Technology, Engineering, and Mathematics Project-Based Learning: Merging Rigor and Relevance to Increase Student Engagement. *Electronic International Journal of Education, Arts, and Science*, 3(6), 140–158.
- da Silva, V. G., & de Souza, R. M. S. (2017). E-Learning, B-Learning, M-Learning And The Technical And

MS, G.D.T., Parwati, N.N., Warpala, I.W.S., Sudatha, I.G.W., Sudarmika, P. & Suartama, I.K. (2022). The impact of project-based E-learning on cognitive and psychomotor learning achievement in sports massage courses. *Cypriot Journal of Educational Science*. 17(12), 4393-4408 <https://doi.org/10.18844/cjes.v17i12.7913>

Pedagogical Aspects On The New Platform Trends As Massive Open Online Courses. *Conference Paper*, (pp. 1–10. <https://doi.org/10.21125/iceri.2016.0239>

Divayana, D. G. H., Sudirtha, I. G., & Suartama, I. K. (2021). Digital Test Instruments Based on Wondershare-Superitem for Supporting Distance Learning Implementation of Assessment Course. *International Journal of Instruction*, 14(4), 945–964. <https://doi.org/10.29333/iji.2021.14454a>

Efendy, B. A., Hanif, A. S., Sulaiman, I., El, M., & Lanos, C. (2022). Android-Based Material for Sports Massage Learning. *International Journal of Human Movement and Sports Sciences*, 10(1), 112–120. <https://doi.org/10.13189/saj.2022.100116>

Elgort, I., Smith, A. G., & Toland, J. (2008). Is wiki an effective platform for group course work? *Australasian Journal of Educational Technology*, 24(2), 195–210. <https://doi.org/https://doi.org/10.14742/ajet.1222>

Fadhilatunisa, D., Fakhri, M. M., & Rosidah. (2020). The Effect of Blended Learning on Learning Activities and Learning Outcomes of Accounting Students. *Jurnal Akuntansi Indonesia*, 18(2), 93–106.

Fajarwati, S. K., Susilo, H., & Indriwati, S. E. (2017). Pengaruh Project Based Learning Berbantuan Multimedia Terhadap Keterampilan Memecahkan Masalah Dan Hasil Belajar Psikomotor Siswa Kelas XI SMA. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, 2(3), 315–321.

Galloway, K. R., & Bretz, S. L. (2015). Using Cluster Analysis to Characterize Meaningful Learning in a First-Year University Chemistry Laboratory Course. *Chemistry Education Research and Practice*, 00(1–3), 1–16. <https://doi.org/10.1039/x0xx00000x>

García-Sillero, M., Benítez-Porres, J., García-Romero, J., Bonilla, D.A.; Petro, J. L., & Vargas-Molina, S. (2021). Comparison of Interventional Strategies to Improve Recovery after Eccentric Exercise-Induced Muscle Fatigue. *International Journal of Environmental Research Public Health*, 18(647), 1–11. <https://doi.org/https://doi.org/10.3390/ijerph18020647>

Grokholskyi, V. L., Kaida, N. I., Albul, S. V., Ryzhkov, E. V., & Trehub, S. Y. (2020). Cognitive and metacognitive aspects of the development of lifelong learning competencies in law students. *International Journal of Cognitive Research in Science, Engineering and Education*, 8(2), 1–14. <https://doi.org/10.5937/IJCRSEE2002001G>

Hidayati, N., Zubaidah, S., Suarsini, E., & Praherdhiono, H. (2020). Cognitive Learning Outcomes : Its Relationship with Communication Skills and Collaboration Skills through Digital Mind Maps-Integrated PBL. *International Journal of Information and Education Technology*, 10(6), 443–448. <https://doi.org/10.18178/ijiet.2020.10.6.1404>

Hizbullah, Q., Tamrin, A. G., Lilo, T., & Sucipto, A. (2018). Comparison Between Project Based Learning Aided “ Edmodo ” and Conventional Learning For Learning Outcomes of Two Dimentional Animation Techniques [Experimental Eleventh Grade Students of Vocational High School Batik 2 Surakarta]. *Journal of Informatics and Vocational Education (JOIVE)*, 1(1), 44–48. <https://doi.org/https://doi.org/10.20961/joive.v1i1.35764.1>.

Hussein, L. A., & Hilmi, M. F. (2020). Cloud Computing Based E-Learning in Malaysian Universities. In *International Journal: Emerging Technologies in Learning*, 15. <https://doi.org/https://doi.org/10.3991/ijet.v15i08.11798>

Kasilingam, G., Ramalingam, M., & Chinnavan, E. (2014). Assessment of learning domains to improve student ' s learning in higher education. *Journal of Young Pharmacists*, 6(4), 27–33.

- MS, G.D.T., Parwati, N.N., Warpala, I.W.S., Sudatha, I.G.W., Sudarmika, P. & Suartama, I.K. (2022). The impact of project-based E-learning on cognitive and psychomotor learning achievement in sports massage courses. *Cypriot Journal of Educational Science*. 17(12), 4393-4408 <https://doi.org/10.18844/cjes.v17i12.7913>
- <https://doi.org/10.5530/jyp.2014.1.5>
- Kramarski, B., & Mevarech, Z. R. (2015). Enhancing Mathematical Reasoning in the Classroom: The Effects of Cooperative Learning and Metacognitive Training. *American Educational Research Journal* , 40(1), 281–310. <https://doi.org/10.3102/00028312040001281>
- Kuhn, D., & Dean. D. Jr. (2004). Metacognition : A Bridge Between Cognitive Psychology and Educational Practice. *Theory Into Practice*, 43(4), 268–274. <https://doi.org/10.1207/s15430421tip4304>
- Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices : Teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education*, 48(1), 103–122. <https://doi.org/10.1080/0305764X.2016.1259389>
- Mathew, J. S. (2017). Self-perception and Academic Achievement. *Indian Journal of Science and Technology*, 10(14), 1–6. <https://doi.org/10.17485/ijst/2017/v10i14/107586>
- Munawaroh. (2017). The Influence of Teaching Methods and Learning Environment to the Student's Learning Achievement of Craft and Entrepreneurship Subjects at Vocational High School. *International Journal of Environmental & Science Education*, 12(4), 665–678.
- Mustafa, P. S., & Dwiyoogo, W. D. (2020). Kurikulum Pendidikan Jasmani, Olahraga, dan Kesehatan di Indonesia Abad 21. *JARTIKA Jurnal Riset Teknologi Dan Inovasi Pendidikan*, 3(2), 422–438. <https://doi.org/10.36765/jartika.v3i2.268>
- Nuryati, D. W., Masitoh, S., & Arianto, F. (2020). Pengaruh Project Based Learning Terhadap Kreativitas Peserta Didik di Masa Pandemi. *Educate : Jurnal Teknologi Pendidikan*, 5(2), 98–106. <https://doi.org/10.32832/educate.v5i2.3375>
- Parwati, N. N., & Suharta, I. G. P. (2020). Effectiveness of the Implementations of Cognitive Conflict Strategy Assisted by e-Service Learning to Reduce Student's Mathematical Misconceptions. *International Journal of Emerging Technologies in Learning*, 15(11), 102–118. <https://doi.org/10.3991/ijet.v15i11.11802>
- Popa, C. E., Dobrescu, T., & Vasile, ". (2017). The effectiveness of massage and muscle energy techniques in treating the myofascial syndrome in the back. *Journal of Physical Education and Sport ® (JPES)*, 17(5), 2325–2328. <https://doi.org/10.7752/jpes.2017.s5253>
- Popov, V., Brinkman, D., Biemans, H. J. A., Mulder, M., Kuznetsov, A., & Noroozi, O. (2012). International Journal of Intercultural Relations Multicultural student group work in higher education An explorative case study on challenges as perceived by students. *International Journal of Intercultural Relations*, 36(2), 302–317. <https://doi.org/10.1016/j.ijintrel.2011.09.004>
- Qholby, W., & Lazulva. (2020). Pengaruh Penerapan Project Based Learning Melalui Google Classroom Terhadap Hasil Belajar Siswa Pada Materi Laju Reaksi. *Journal of Research and Education Chemistry*, 2(1), 23–29. [https://doi.org/10.25299/jrec.2020.vol2\(1\).4863](https://doi.org/10.25299/jrec.2020.vol2(1).4863)
- Radziejowska, M., Radziejowski, P., & Romaniv, O. (2020). Effects of massaging upper limb parts in different order on changing the level of blood circulation in the massaged area. *Journal of Physical Education and Sport*, 20(6), 3273–3279. <https://doi.org/10.7752/jpes.2020.s6444>
- Safaruddin, S., Ibrahim, N., Juhaeni, J., Harmilawati, H., & Qadrianti, L. (2020). The Effect of Project-Based Learning Assisted by Electronic Media on Learning Motivation and Science Process Skills. *Journal of Innovation in Educational and Cultural Research*, 1(1), 22–29.

- MS, G.D.T., Parwati, N.N., Warpala, I.W.S., Sudatha, I.G.W., Sudarmika, P. & Suartama, I.K. (2022). The impact of project-based E-learning on cognitive and psychomotor learning achievement in sports massage courses. *Cypriot Journal of Educational Science*, 17(12), 4393-4408 <https://doi.org/10.18844/cjes.v17i12.7913>
- <https://doi.org/10.46843/jiecr.v1i1.5>
- Sanjaya, D. B., Suartama, I. K., Suastika, I. N., & Sukadi. (2022). The Effect of the Conflict Resolution Learning Model and Portfolio Assessment on the Students' Learning Outcomes of Civic Education. *International Journal of Instruction*, 15(1), 473–488. <https://doi.org/10.29333/iji.2022.15127a>
- Santyasa, I. W., Agustini, K., & Eka Pratiwi, N. W. (2021). Project Based E-Learning and Academic Procrastination of Students in Learning Chemistry. *International Journal of Instruction*, 14(3), 909–928. <https://doi.org/10.29333/iji.2021.14353a>
- Santyasa, I. W., Rapi, N. K., & Sara, I. W. W. (2020). Project based learning and academic procrastination of students in learning physics. *International Journal of Instruction*, 13(1), 489–508. <https://doi.org/10.29333/iji.2020.13132a>
- Sari, L. S., Sulistiono, A. A., & H, W. L. (2020). Effect of psychomotor development on physical health , mental health and student achievement. *International Journal of Educational Policy Research and Review*, 7(6), 228–240. <https://doi.org/https://doi.org/10.15739/IJEPRR.20.024>
- Seels, B. (1995). Classification Theory , Taxonomic Issues , and the 1994 Definition of Intructional Technology. *The Annual Meeting of the Association for Educational Communications and Technology*, 1–37. Anaheim, CA: DUCATIONAL RESOURCES INFORMATION CENTER (ERIC).
- Shin, M.-H. (2018). Effects of project-based learning on students' motivation and self-efficacy. *English Teaching*, 73(1), 95–115. <https://doi.org/10.15858/engtea.73.1.201803.95>
- Stanković, Z., Maksimović, J., & Osmanović, J. (2018). Cognitive theories and paradigmatic research posts in the function of multimedia teaching and learning. *International Journal of Cognitive Research in Science, Engineering and Education*, 6(2), 107–114. <https://doi.org/10.5937/ijcrsee1802107S>
- Suartama, I. K., Mahadewi, L. P. P., Divayana, D. G. H., & Yunus, M. (2022). ICARE Approach for Designing Online Learning Module Based on LMS. *International Journal of Information and Education Technology*, 12(4), 305–312. <https://doi.org/10.18178/ijiet.2022.12.4.1619>
- Suartama, I. K., Setyosari, P., Sulthoni, Ulfa, S., Yunus, M., & Sugiani, K. A. (2021). Ubiquitous Learning vs . Electronic Learning : A Comparative Study on Learning Activeness and Learning Achievement of Students with Different Self-Regulated Learning. *International Journal of Emerging Technologies in Learning (IJET)*, 16(03), 36–56. <https://doi.org/https://doi.org/10.3991/ijet.v16i03.14953>
- Suastika, I. N., Suartama, I. K., & Sanjaya, D. B. (2022). Urgency of social media-based civics education instruction in higher education. *World Journal on Educational Technology: Current Issues*, 14(3), 630–643. <https://doi.org/10.18844/wjet.v14i3.7198>
- Sudarma, I. K., Prabawa, D. G. A. P., & Suartama, I. K. (2022). The Application of Information Processing Theory to Design Digital Content in Learning Message Design Course. *International Journal of Information and Education Technology*, 12(10), 1043–1049. <https://doi.org/10.18178/ijiet.2022.12.10.1718>
- Sudarmika, P., Santyasa, I. W., & Divayana, D. G. H. (2020). Comparison between Group Discussion Flipped Classroom and Lecture on Student Achievement and Student Characters. *International Journal of Instruction*, 13(3), 171–186. <https://doi.org/10.29333/iji.2020.13312a>
- Sulistyorini, Yunus, M., & Supriatna. (2020). Life-Based Learning Approach on Massage Course in College

- MS, G.D.T., Parwati, N.N., Warpala, I.W.S., Sudatha, I.G.W., Sudarmika, P. & Suartama, I.K. (2022). The impact of project-based E-learning on cognitive and psychomotor learning achievement in sports massage courses. *Cypriot Journal of Educational Science*. 17(12), 4393-4408 <https://doi.org/10.18844/cjes.v17i12.7913>
- Students. *Advances in Health Sciences Research*, 29, 133–135.
- Sumarni, W., Wardani, S., & Gupitasari, D. N. (2016). Project Based Learning (PBL) to improve psychomotoric skills: A classroom action research. *Jurnal Pendidikan IPA Indonesia*, 5(2), 157–163. <https://doi.org/10.15294/jpii.v5i2.4402>
- Suprayitno, Fadli, Z., & Widianingsih, O. (2021). Model of Sport Massage Services on Athlets and Communities Based on Sports Industry. *Advances in Social Science, Education and Humanities Research*, 591(Aisteel), 837–841. <https://doi.org/http://dx.doi.org/10.2991/assehr.k.211110.190>
- Suryani, L., Susilawati, T., & Harjito. (2021). Inovasi Pembelajaran Blended Learning Dengan Metode Project Based Learning Terhadap Motivasi, minat dan Hasil Belajar Siswa di masa Pandemi Covid-19. *Jurnal Tambora*, 5(2), 79–86.
- Syafriafdi, N. (2020). Peran Teknologi Pendidikan Dalam Pembelajaran. *Jurnal Al-Aulia*, 06(01), 1–8.
- Syah, M. (2017). *Educational Psychology*. Bandung: PT Remaja Rosdakarya.
- Syakur, A., & Musyarofah, L. (2019). The Effect of Project-Based Learning (PjBL) Continuing Learning Innovation on Learning Outcomes of English in Higher Education. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, 3(1), 625–630.
- Tamim, S. R., & Grant, M. M. (2013). Definitions and Uses : Case Study of Teachers Implementing Project-based Learning. *Interdisciplinary Journal of Problem-Based Learning Volume*, 7(2), 5–16. <https://doi.org/10.7771/1541-5015.1323>
- Taufiqurrahman, Herpratiwi, & Widodo, S. (2021). Project Based Learning as a Learning Model to Improve Social Skills and Student Creativity. *International Journal of Science and Research (IJSR)*, 10(3), 958–961. <https://doi.org/10.21275/SR21309142239>
- Tuaputty, H., Leasa, M., Corebima, A. D., & Batlolona, J. R. (2021). The Correlation between Critical Thinking Skills and Cognitive Learning Outcomes. *Ilkogretim Online - Elementary Education Online*, 20(1), 302–317. <https://doi.org/10.17051/ilkonline.2021.01.029>
- Yao, J., Sun, H., Tian, Y., & Gu, H. (2019). Project-Based Learning in Chinese Middle-School Students Is More Effective than the Traditional Teaching Method: An Experimental Study. *Science Insights Education Frontiers*, 2(2), 115–121. <https://doi.org/10.15354/sief.19.ar052>
- Yuliana, C. (2020). Project based learning , model pembelajaran bermakna di masa pandemi covid 19. *LPMP Lampung*, 1–10.
- Yunus, M., Amirullah, A., Safiah, I., Ridha, S., & Suartama, I. K. (2022). Development of the CPOL design to improve the ability to develop teaching materials. *Cypriot Journal of Educational Sciences*, 17(5), 1655–1670. <https://doi.org/10.18844/cjes.v17i5.7257>
- Zhang, W., & Zhu, Y. (2017). A New E-learning Model Based on Elastic Cloud Computing for Distance Education. *Journal of Mathematics, Science and Technology Education*, 13(12), 8393–8403. <https://doi.org/10.12973/ejmste/80800>