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RESEARCH ARTICLE

The Implementation of Ergo-Learning 2.0 Strategy in Reducing Fatigue and Improving Speed, Thoroughness and Constancy of Vocational School Students in Semarapura City, Bali

I Wayan Sudiarsa[1]*, N. Adiputra[2], Ketut Tirtayasa[2], I Made Sutajaya[3]

1. *Student of Doctoral Program of Medical Sciences Study Program of Udayana University.*

2. *Lecturer of Medical Sciences Study Program of Udayana University.*

3. *Lecturer of Biology Education Study Program of Ganesha University of Education.*

***Corresponding Author: I Wayan Sudiarsa**

Abstract

The ergo-learning strategy 2.0 is a combination between *e-learning* 2.0 and the principles of ergonomics, so that a humanistic learning process can be generated. This learning strategy was implemented in the form of improving the redesign of the classroom, lighting arrangements, learning media, active break, and stretching using Systemic-Holistic-Interdisciplinary-Participatory (SHIP Approach). This study was an experimental study, conducted using a Randomized Pre- and Post-test Control Group Design. Each group (control and treatment) consisted of 12 people. General fatigue data were collected using a 30 items of rating scale questionnaire with a Likert scale, while speed, thoroughness and constancy data were collected using the Bourdon Wiersma test. The results showed that the ergo-learning strategy 2.0 could reduce fatigue as seen from a decrease in general fatigue by 28.09%, an increase in student speed by 65.91%, an increase in student thoroughness by 50.88% and an increase in student constancy by 48.11%. It is recommended to teachers to implement the *ergo-learning 2.0* strategy in learning and to policy makers in schools to consider applying the principles of ergonomics in the management of Education.

Keywords: *Ergo-Learning 2.0, fatigue, Speed, Thoroughness, Constancy, Ergonomics.*

Introduction

Learning is essentially a major activity in a series of educational processes in schools. The success or failure of educational objectives depends on how the teaching and learning process takes place. There are even differences in learning between a learning process with and without supervision [1].

The learning process in an educational unit must be carried out in interactive, inspirational, fun, challenging, motivating manners to students to participate actively, as well as providing sufficient space for initiative, creativity, and independence in accordance with students' talents, interests, and physical and psychological developments. Fun learning is marked by nervous work [2]. There are various possible learning strategies to apply, including *e-learning* strategy [3, 4, 5, 6]. *E-learning* strategy refers to efforts to make a transformation of the learning process in schools or colleges into digital form using internet technology. This opinion is supported by [7, 8, 9] that *e-learning* is a system or educational concept that utilizes information technology in teaching and learning. *E-learning* develops continuously along with the progress of science and technology and, currently, there has been *e-learning* 2.0 strategy presented that has been widely applied in many schools.

E-learning 2.0 is related to creating and sharing information and knowledge with others using social media, such as blogs, wiki, social bookmarks and social networks in the context of education or training to support collaborative approaches to learning [10]. The presence of this learning strategy is motivated by the fact that today's internet users really like *web 2.0* or *social networking* applications, the web-based applications that are collaborative, interactive and have *user generated contents* [11]. As one generation of *e-learning*, *e-learning 2.0* has various advantages and disadvantages in learning processes. The advantages include learning that is not limited in place and time and it is a *student centered process*, cost-saving (infrastructure, equipment, books, official travel), and encourages students to be more independent in gaining knowledge and assistance online [12], while the advantages include more effort for preparing materials and for paying attention to the pedagogical side of the materials, as well as the students need to be motivated and organized as the students who do not have high motivation often experience failure and lack of interaction between teachers and students which can slow the formation of values in the learning process [13].

In addition to the disadvantages, the application of *e-learning 2.0* in Vocational Schools in the city of Semarapura is also still experiencing some problems, such as students who tend to be less mobile, interactive and having lack of discussion among them, and the microclimate of the classrooms and media that has not been in accordance with the rules of ergonomics. Based on the results of a preliminary study on 31 students who have participated in learning using the *e-learning 2.*0 strategy, there was a fatigue of 62.68 ± 5.22 included in relatively-tired category.

These disadvantages must be anticipated, so that the various advantages of *e-learning 2.0* can lead students to achieve learning objectives in the form of good learning processes and outcomes. The factor of students as learning subjects is very important to note because students have certain skills, abilities and limitations that should be used as physiological parameters related to cardiovascular abilities, muscular abilities, energy requirements and psychological factors, such as boredom, laziness, emotions, lack of concentration, and others [14]. A good learning process will occur if physical, psychological, fatigue and external factors support the learning process of students [15].

The learning process involves physical and mental activities that can integrally cause fatigue, muscle complaints, and boredom. These various impacts can affect the thoroughness, speed, and constancy of students which in the end affect the quality of the learning process [14]. Based on the description above, the fatigue factor must be suppressed as possible so as not to have adverse effect on students. Fatigue is characterized by reluctance to work due to monotonous work, heavy and prolonged physical work, and environmental, mental, health and nutritional conditions.

The characteristics consist of: fatigue, drowsiness, dizziness, neglect and hatred to work, slow thinking, lack of vigilance, low perception and slow performance due to decreased mental performance [16]. Fatigue decreases performance and increases mistakes, thus, providing opportunities for getting accident at work [17]. An alternative solution to this problem is by making an intervention on *e-learning 2.0* strategy with ergonomic rules that have often escaped from the attention of the education world.

Ergonomic intervention on *e-learning 2.0* strategy will produce *ergo-learning 2.0* strategy which is a combination between electronic-based learning, especially for web-based learning 2.0 known as *e-learning 2.0*, and ergonomics approach. This study attempted to integrate both strategies into a new learning strategy, namely *ergo-learning 2.0* in order to reduce fatigue, especially for vocational school students in Semarapura in the learning processes.

The integration of learning strategies can produce better output [18, 19, 20].This learning strategy is implemented in the form of integrated learning where face-to-face learning in class is complemented by *Edmodo*-based social networking learning which is an implementation of *e-learning 2.0* and has often been used as learning media.

The preparation of subject materials, both through *Edmodo* and face-to-face learning in the classroom, is based on an ergonomics-based learning strategy by making improvements to the learning system such as improving the redesign of the classroom, lighting arrangements, learning media, active break, and stretching using Systemic-Holistic-Interdisciplinary-Participatory(SHIP Approach).

The SHIP approach has been implemented on various issues [21, 22, 23].The redesign of the classroom was carried out by setting up a discussion table separately from the computer table which allows students to move dynamically during the learning processes, so that they don't just sit in front of the computer screen. The redesign of the classroom was also done by lowering the height of the LCD screen and adjusting the height of the blackboard to suit students' anthropometry.

Improvements were also made to the lighting of the classroom and the learning media used to conform to the rules of ergonomics. Learning media elements, such as font size and color used were re-arranged to avoid eye fatigue on students. Active break and muscle stretching were provided to enable recovery and increase student comfort in learning.

Interaction and discussion between students that have not been conducive were improved through the application of the SHIP approach, which is a learning process based on systemic, holistic, interdisciplinary and participatory principles that enable students to take active breaks, dominated by dynamic muscular contraction, not being in one place in relatively long time, more free to interact with friends and teachers, more open in expressing their opinions, utilize learning time effectively and efficiently, are better to work in teams and always study problems holistically and systemically [14].

Various improvements have been made to produce positive physiological responses in the learning process, one of which is to reduce student fatigue as seen from a decrease in general fatigue, as well as an increase in the speed, thoroughness and constancy of students in the learning process. The ergonomic approach becomes one of the models in solving work life problems [24, 25].

Research Method

This study was an experimental study, conducted using a *Randomized Pretest and Posttest Control Group Design*. This design is a parallel design, consisting of two sample groups namely, Control and Treatment Groups. The target population of this study was vocational school students in Semarapura city, Klungkung Regency. Accessible population was vocational students in Semarapura City who have been using *e-learning 2.0* in their learning.

The sample was divided into two groups randomly and each group consisted of 12 people. General fatigue data were collected using questionnaires with *30 items of rating scale* and a valid and reliable Likert scale which has been used internationally. Meanwhile, the speed, thoroughness and constancy data were collected by conducting the *Bourdon Wiersma* test. The data obtained were then analyzed using SPSS (*Statistical Package for the Social Sciences*) version 17.0 *for Windows* to test the established hypotheses, preceded by descriptive analysis and normality tests.

Results and Discussion

The results of the prerequisite test analysis of the characteristic data in the control and the treatment groups were normally distributed, so that it was followed by parametric analysis at a significance level of 5% ($\alpha = 0.05$).

Table 1: Results of hypothesis test on the characteristics of research subject

Variable	Control Group		Treatment Group		t-value	P-value
	Mean	SD	Mean	SD		
Height (cm)	157.99	5.99	158.67	6.84	-0.26	0.80
Weight (kg)	49.50	5.25	52.33	5.79	-1.26	0.22
Age (year)	16.08	0.90	16.25	0.87	-0.46	0.65
Body Mass Index	19.79	1.19	20.75	1.44	-1.79	0.09

Information: SD = Standard Deviation

Table 1 show that the subject's condition is comparable since all p values > 0.05. It means that height; weight, age and body mass index of the subject did not have any effect on the results of the study which were solely influenced by the treatment applied in this study. Respondent characteristics in other studies are needed as initial information of the study [26, 27]. This study also examined the effect of gender on the dependent variables which was preceded by a normality test on general fatigue, speed, thoroughness and constancy data.

Table 2: Results of t-test on the effect of gender on dependent variables

Variable	Mean		t-Value	p-Value
	Men (n=6)	Woman (n=18)		
General Fatigue	50.50	49.37	0.63	0.53
Speed	10.12	9.92	0.28	0.78
Thoroughness	5.78	6.85	-1.34	0.22
Constancy	4.23	4.01	0.71	0.48

Table 2 shows that gender does not have any effect on general fatigue, speed, thoroughness and constancy of the students since all p values > 0.05. It means that gender segregation in further analysis is not necessary. The mean for height of vocational school students in Semarapura city as research subjects was 157.99 ± 5.99 cm in the control group and 158.67 ± 6.84 cm in the treatment group.

The mean for weight in the control group was 49.50 ± 5.25 kg and in the treatment group was 52.33 ± 5.79 kg. From the comparability test results, it was found that the height and weight of the students between the control group and the treatment group were comparable (p> 0.05).

This means that the height and weight of students between the control group and the treatment group did not have significant difference, so that both variables did not have any effect on the results of the study. Based on height and weight data, body mass index (BMI) was in a range between 18.52-22.76 kg/m^2 where the mean for body mass index in the control group was 19.79 ± 1.19 kg and in the treatment group was 20.75 ± 1.44 kg.

BMI was used as a health parameter for respondents [28, 29, 30, 31].The mean BMI shows the subject's nutritional status within normal limits, so that the physical condition of the subject is healthy, has no problems with nutrition and can carry out learning activities optimally. Furthermore, from the comparability test results, it was found that the height and weight of the students between the control and the treatment group were comparable (p > 0.05) which means that the students' height and weight were assumed to have no effect on the results of the study. The mean age of vocational school students in Semarapura city as research subjects was 16.08 ± 0.90 years in the control group and 16.25 ± 0.87 years in the treatment group.

The mean age is in the productive age range, where subjects can perform activities with optimal physical strength because a person's physical capacity is directly proportional to age to certain limits and reaches a peak at the age of 25 years and the increasing age will affect one's ability to carry out activity [32]. Furthermore, from the comparability test results, it was found that the age of students between the control group and the treatment group was comparable (p> 0.05) which means that the age of the students was assumed to have no effect on the results of the study.

Environmental Condition

The results of the analysis of the prerequisite tests on environmental conditions using the ShapiroWilk Test on variable noise, wind speed, temperature, relative humidity and intensity are normally distributed, followed by parametric analysis using a t-group test with a significance level of 5% (α = 0.05).

Table 3: Results of hypothesis test on environmental conditions in the classroom

Variable	Control Group		Treatment Group		t-Value	p-Value
	Mean	SD	Mean	SD		
Noise (dB)	53.10	1.85	53.47	0.93	-0.53	0.60
Wind Spped (m/s)	0.07	0.02	0.06	0.02	1.41	0.18
Temperature (°C)	25.08	0.22	24.96	0.48	0.70	0.50
Light Intensity (lux)	214.09	4.05	259.20	4.56	-22.16	0.00

Information: SD = Standard Deviation

Table 3 shows that environmental conditions seen from noise, wind speed, temperature, and relative humidity in the classroom between the control and treatment groups are comparable since the p-value > 0.05. Meanwhile, the light intensity has a p-value < 0.05, which means the mean light intensity in the control group is significantly different from the mean light intensity in the treatment group. Based on the data of the environmental conditions in the classroom shown in Table 3, it can be seen that both the control and treatment groups meet the rules of ergonomics in terms of noise, wind speed, relative humidity or temperature. Ergonomic rules for classroom are air temperature between 230-260, relative humidity between 40%-60% [33], maximum wind speed of 0.2 m/second [34] and maximum noise of 55 dB. Meanwhile, for the lighting, a classroom that meets the rules of ergonomics have a light intensity of 250 lux minimum. Thus, the classroom for the treatment group meets the ergonomic rules while the classroom for the control group does not. The results of comparability test showed that temperature, noise, wind speed and relative humidity both in the control and treatment groups were comparable (p>0.05). Therefore, these variables do not have significant differences, so that they do not have any effect on the results of the study. Meanwhile, the light intensity in the control and treatment groups has p-value < 0.05, as the light for both groups was significantly different due to the intervention in the treatment group.

Table 4: Results of analysis on fatigue data of vocational school students in Semarapura City

Variable	Control Group		Treatment Group		t-Value	p-Value
	Mean	SD	Mean	SD		
1. Before learning						
a. General fatigue	35.72	3.38	35.00	1.98	0.64	0.53
b. Speed	-8.46	1.35	-8.67	1.17	-0.44	0.66
c. Thoroughness	-4.86	2.90	-4.56	1.16	0.34	0.74
d. Constancy	-2.66	0.81	-2.64	0.62	-0.04	0.66
2. After learning						
a. General fatigue	52.17	1.00	46.83	3.32	5.39	0.00
b. Speed	-10.56	1.39	-9.38	1.24	2.18	0.04
c. Thoroughness	-7.14	1.29	-6.03	1.20	2.18	0.04
d. Constancy	-4.54	0.47	-3.59	0.8	2.18	0.04

Table 4 shows that general fatigue, speed, thoroughness and constancy of vocational school students in Semarapura before learning between the control and treatment groups were comparable since the p-value > 0.05. While the mean for general fatigue, speed, thoroughness and constancy after learning process in the control group were significantly different from the mean for speed, thoroughness and constancy in the treatment group (p < 0.05). Likewise, the mean difference in general fatigue, speed, thoroughness and constancy of the control group has significant difference from the mean for speed, thoroughness and constancy in the treatment group (p < 0.05).

General Fatigue of Students in Learning Process

The mean for general fatigue of students before learning process in the control group was 35.73 ± 3.38 and 35.00 ± 1.98 in the treatment group. After learning process, the fatigue has increased in the control group to 52.17 ± 1.00 and to 46.38 ± 3.32 in the treatment group. It can be seen that the increase in fatigue in the control group is higher than in the treatment group. The difference or increase in fatigue in the control group was 16.45 ± 0.94; the increase in fatigue in the treatment group was only 11.83 ± 2.99 or decreased by 28.09%. Both groups, both before and after learning process, were categorized as not tired. It means that students in both groups were not tired in the learning process.

The reason is the use of e-*learning 2.0* strategy that is able to provide interesting learning, so students do not feel tired and the learning is only run for 90 minutes. The results of the comparability test for the average general fatigue score before the learning process between the control group and the treatment group are comparable (p > 0.05). It means that the general fatigue of students before the learning process has no difference. General fatigue after the learning process between the control group and the treatment group has significant difference (p < 0.05).

The implementation of the *ergo-learning* 2.0 strategy can reduce general fatigue by 28.09%. This is in line with other studies that ergonomic improvements can reduce work fatigue [35, 36]. The reduction in fatigue is caused by several factors including optimized lighting, which is adjusted to SNI 03-6197-2000 which requires the recommended light intensity for classroom activities with a minimum of 250 lux, the height of the LCD screen is adjusted to the student's anthropometry so that students' work attitudes become physiological, students who are constantly engaged in the learning process so that the work of muscles becomes more dynamic, learning media that meet the rules of ergonomics, and the provision of stretching and active breaks.

Boring learning situations in the control group can be transformed into pleasant situations which also act as a cause of reduced fatigue in the treatment group. Similar results [37], found that an ergonomics-based community science and technology approach can reduce fatigue by 34.90%. The ergonomics approach needs to be carried out holistically and make users as part of the main improvements before other improvements are made. The final goal of ergonomics is the quality of life [38].

Speed, Thoroughness, and Constancy of Students in Learning Process

Based on the comparability test results, it was found that: (a) the speed of students before the learning process between the control group and the treatment group is comparable ($p > 0.05$) or the condition of students as seen from the speed factor before the learning process is the same; (b) the thoroughness of students before the learning process between the control group and the treatment group is comparable ($p > 0.05$) or the condition of students as seen from the thoroughness factor before the learning process is the same; and (c) the constancy of students before the learning process between the control group and the treatment group is also comparable ($p > 0.05$) or the condition of students as seen from the constancy factor before the learning process is the same. The results of the comparability test on the differences of the mean speed scores between the control and treatment group showed a significant difference ($p < 0.05$). The speed in the treatment group was 65.91% higher than the control group. The results of the comparability test on the differences between the mean thoroughness scores in the control group and the treatment group after the learning process showed a significant difference ($p < 0.05$). Likewise, results of the comparability test on the differences between the mean thoroughness scores of the control group and the treatment group showed a significant difference ($p < 0.05$). The mean constancy scores in the control group and treatment group after the learning process showed a significant difference ($p < 0.05$).

Likewise, the results of results of the comparability test on the differences between the mean constancy scores in the control group and the treatment group showed a significant difference ($p < 0.05$). Constancy in the treatment group was 48.11% higher than in the control group. It means that *ergo-learning 2.0* strategy can significantly reduce student fatigue ($p < 0.05$) where students will be faster, more thorough and constant in their activities. The concept of ergonomics is able to solve problems in learning [39, 40, 41].

Conclusions and Recommendations

Based on the results of the analysis and discussion. It can be concluded that the *ergo-learning 2.0* strategy can reduce fatigue as seen from the decrease in general fatigue of students by 28.09%, an increase in students' speed by 65.91%, an increase in students' thoroughness by 50.88%, students' constancy by 48.11%. There are some recommendations from this study for vocational school or equivalent level school teachers to try to implement an *ergo-learning 2.0* strategy in learning because this strategy has been proven to be able to improve the quality of the learning processes. It is expected that policy makers in schools to apply the principles of ergonomics in the management of Education to create effective, comfortable, safe, healthy and efficient learning.

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