Student-centered learning models and learning outcomes: meta-analysis and effect sizes on the students’ thesis

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Abstract - A meta-analysis of students’ thesis is very necessary to improve the quality of research in maintaining the consistency and scientific truth justification of the theory. This study aims to (i) obtain an effect-size estimation, which is the strength of the relationship between the variables studied in a quasi-experimental study; (ii) describe the effectiveness of student-centered learning models compared to teacher-centered learning on learning outcomes; (iii) describe the conditions that affect the effectiveness of the student-centered learning models in the final assignments of students of Informatics Engineering, Universitas Pendidikan Ganesha. In order to achieve this goal, 22 students’ final assignments were reviewed as research samples. The study focused on two things, namely, (a) calculating the effect size of each sample of the theses; (b) examining the theoretical and empirical justification used to discuss the acceptance of the hypothesis. Statistical analysis techniques were used to determine the value of the effect size. The results showed, the effect-size value for the entire sample was 1.109 in the high category. Then, the results of the study of the t value for all the thesis studied showed all t-count values were greater than t-table values at a significant level of 0.05. It means student-centered learning models are better than teacher-centered learning models on the learning outcome variables studied.

1. Introduction
To improve the mastery of graduates’ concepts and competencies through quality learning services, applying innovative learning models is an important part of supporting the learning process. The innovative learning model has shifted the learning paradigm from teacher-centered learning to student-centered learning. Student-centered learning teaches students to be independent, have self-regulation, and take responsibility for their learning activities, and manage themselves in the learning process. Besides, trends in the era of industrial revolution 4.0 where 21st-century teachers are required to integrate Technology, Pedagogy, and Content Knowledge (TPACK) in their learning activities[1]

Improving the quality of education and learning becomes a demand for institution and study program. The final point of improving the quality of learning is the production of quality final assignments by students. The quality of the thesis refers to two aspects, (i) the research process that is in accordance with the theories of the research methodology; (ii) the analysis of the results which are in accordance with theoretical and empirical evidence. The thesis created by Informatics Engineering Education program graduates is divided into four area groups, namely development research, quasi-experimental research, survey or ex post facto research, and classroom action research.
Development research and quasi-experimental research are quite dominant compared to classroom action research or survey/ex post facto research in the students’ thesis. Especially for experimental research, most of the thesis examine the comparison of the independent variables of innovative and conventional learning models on various types of learning outcomes. The innovative learning models with the student-centered learning paradigm (herein after referred to as the student-centered learning models) used vary widely, which refers to the student-centered learning paradigm. The variations of learning models and strategies are used as a stimulus to conduct a review of the thesis research results’ quality. The review is carried out by reviewing the thesis’ results using the meta-analysis method.

Meta-analysis of students’ final assignments is very necessary to maintain and improve their quality. The quality in question is the consistency of the research results and the scientific truth justifying the theory. The regularity study of research results is carried out because of the increasing number of replication or verification of research in the students’ final assignments, which often increases the variation in research results. Another consideration of using meta-analysis method is to get a general conclusion from the thesis that examines the effect of innovative learning on learning outcomes.

Then, the relation between the independent variables (learning models/strategies) and the dependent variable (learning outcomes/learning achievements) is related to the scientific truth of the theoretical justification used to answer research problems. The study of these two variables will provide an overview of the extent to which the effectiveness of the process (learning actions) understudy can affect the achievement of learning outcomes. This study also concerns a comprehensive study of student learning activities based on the learning stages carried out during the research. Is it true the student learning activities effectively and scientifically affects student learning outcomes? For that, it is necessary to do a deeper study of the relationship between learning outcomes and the learning model/strategy used.

Referring to the reasons stated above, the study through meta-analysis of student’s final assignments is increasingly urgent to do. Therefore, an estimate of the effect size will be obtained, namely the strength of the relationship or the magnitude of the differences between research variables and to get a more natural overview between models/strategies. innovative learning (student-centered learning) and research learning outcomes.

2. Material and Methods

2.1 Literature Review

Learning outcomes have been an interesting study in various studies, especially in the field of education and learning psychology. It is due to learning outcomes are one of the benchmarks of one's success in the academic world [2] [3]. Therefore, learning outcome is always considered as an important problem in the world of education at all levels. Learning outcomes are believed to play a role in several aspects of life such as anxiety, self-esteem, and optimism[4]. Students who have high learning outcomes also tend to have strong motivation and competitiveness compared to students who have low learning outcomes.

There are several domains involved in learning outcomes, namely cognitive, affective, and psychomotor. The cognitive domain is one of the psychology domains which includes any mental behavior related to understanding, consideration, information processing, problem-solving, gaps, and beliefs [5] [6] [7]. The cognitive domain is related to conation (will) and effect (feeling). The cognitive domain is both a source and a controller for other domains, namely affective and psychomotor. Research findings show that in learning, intellectual (cognitive) abilities play a big role, especially in the learning outcomes achieved by a person [8].

Cognitive abilities that are important to the learning process covers strategies to understand the content (material) of the lesson, strategies to believe in the importance of the content of the subject matter and its application, and to absorb the values contained in the content of the lesson [8] [9] [10]. In other words, the learning model used is very important, so that learning can run effectively and efficiently. The learning model used is not only an active learning strategy [11], but it must be a learning
model that can optimally lead students to achieve predetermined learning indicators / goals. The achievement of learning objectives refers to students' understanding of the material internally (internalizing the value of the subject matter).

Learning is a process consisting of input, process, and output, it is important to pay attention to the learning process to get good learning outcomes. According to [12], a student will get good learning outcomes if the student is aware and responsible in the learning process, and knows how to learn efficiently. [12] termed such a learner as a self-regulated learner. A self-regulated learner takes responsibility for his/her learning activities. Almost all student-centered learning models suggest students to organize themselves in the learning process.

Self-regulated learner in the learning process is (1) defining the goals and problems they may face in achieving learning goals; (2) developing a standard level of perfection in achieving learning objectives; and (3) evaluating the best way to achieve learning objectives. These three things are learning activities carried out by students. These learning activities are adjusted to the stages of the learning model being studied. These things should be used as a foothold by the researcher in justifying the results of proving the hypothesis. In other words, the theoretical justification associated with student learning activities during the study should contain the following descriptions: (1) an explanation of the strategies undertaken by students to achieve the learning outcomes under study; (2) explanation of students' strategies for correcting their mistakes; and (3) an explanation of the students' strategies to redirect themselves when the lesson plans are not going well.

Based on the presentation of the central issues underlying this meta-analysis research, the following can be conveyed. First, although it is known that there are many factors that influence the low achievement of learning outcomes, the quality factor of learning management is seen as a very significant factor. Second, learning management is strongly influenced by the choice of innovative learning models to be applied. Third, the most important part in implementing innovative learning models is the operationalization of the stages into effective and efficient student learning activities. Fourth, effective and efficient student learning activities as predictors of the expected achievement of learning outcomes. Therefore, it is necessary to conduct a meta-analysis study to obtain an estimate of the strength of the relationship between the variables studied. In addition, it is necessary to study the effectiveness of an innovative learning model with a student centered learning paradigm compared to a teacher-centered learning model on learning outcomes and describe what conditions affect the effectiveness of innovative learning models in the quasi-experimental thesis of Informatics Engineering Education.

2.2 Selection Criteria

The study is focused on two things, namely (a) examining the effect size (r, t, or F) of each sample thesis, which shows the direct relationship between the student-centered learning model and learning outcomes and (b) examines the theoretical and empirical justification which is used to discuss acceptance of the hypothesis. The effect size study was carried out by finding the mean difference between the experimental class (using student-centered learning) and the teacher-centered learning average. Then, it is divided by the standard deviation of the control class [13].

The population of this research is the theses that have been created by students of Informatics Engineering Education, Ganesha University of Education between 2015-2019. Then, all of these final assignments are sorted to obtain research samples. Determination of the research sample using purposive sampling, namely determining the thesis in accordance with the research objectives. The final sample project is a quasi-experimental thesis with independent variables in the form of innovative learning models / strategies with the student-centered learning paradigm and the dependent variable in the form of learning outcomes that are limited to abilities related to cognitive domains, which involve factual knowledge to metacognition.

The keywords used to determine the thesis to be reviewed are, innovative learning models, student-centered learning, innovative learning strategies, and learning outcomes. The components of selected primary data obtained from the 2015-2019 research results will be reviewed. These components are
problem formulation, population and samples, research data, analysis techniques and results of hypothesis testing and discussion.

2.3 Calculation of effect size and description analysis
The data analysis technique used is statistical analysis and descriptive analysis. Statistical analysis refers to the steps of the Statistical Analysis technique according to [14], the details of the stages are as in Table 1.

|   |   |
|---|---|
| 1 | Transform the value of F into t and r |
| 2 | *Bare-Bones meta Analysis*, which is used to determine the sample error correction, perform measurement error correction calculations |
| 3 | Determine the value of the effect size (d), which is to find the difference between the experimental class average (Xe) and the control class average (Xc), then divided by the control class standard deviation (Sp). The formula used is, \( d = \frac{Xe - Xc}{Sp} \), \( d = \text{effect size}; Xe = \text{experimental group average}; Xc = \text{control group average}; Sp = \text{control class standard deviation} \).

The categories for the criteria for the effect size (d) according to [15] are,

|   |   |
|---|---|
| 0<d<0.2 | belongs to the small effect category (mean difference is less than 0.2 standard deviation) |
| 0.2≤d≤0.8 | belongs to the medium effect category (mean difference of about 0.5 standard deviation) |
| d > 0.8 | belongs to the large effect category (the mean difference is more than 0.8 standard deviation) |

After the statistical analysis is carried out, the next step is to carry out a descriptive analysis in order to:

(i) describe the effectiveness of student-centered-learning models compared to teacher-centered-learning models on learning outcomes;
(ii) describe the conditions that affect the effectiveness of student-centered-learning models, and
(iii) describe the strengths and weaknesses of the research that has been carried out through the study of methods and data analysis as well as the results of the research from each of the final assignments that are used as samples.

3. Result and Discussion
The number of documented theses in 2019 is 126. Of these 126, 22 were selected experimental studies that met the objectives of this study. Meanwhile, the remaining 104 distributed into development research, survey, correlational, ex post facto, and classroom action research. Many scientific publications of the final assignments’ results of are published in three journals, namely the Janapati, Karmapati, and JPTK journals.

The level of education used as a place for research is very diverse, namely TK (PAUD), SMP, SMA, and SMK levels. Most of the thesis studied use the SMK level as a place of research. The study field which becomes the research area is the ICT field. A total of 22 final assignments were analyzed using independent variables in the form of innovative learning models with a diverse student-centered learning paradigm, where this diversity can be categorized into three as in table 2. While the teacher-centered learning independent variables only use two terms, namely conventional learning or direct learning.
Table 2. Diversity of student-centered learning models.

| No | Diversity in model | Model of student-centered learning                                      |
|----|--------------------|------------------------------------------------------------------------|
| 1  | Cognitive based model | Inquiry, problem-based learning, project-based learning, contextual, portfolio |
| 2  | Society based model | Cooperative, STAD, JIGSAW, TGT, NHT, GI                                 |
| 3  | IT based model      | E-module products, e-learning, multimedia, VR products, AR              |

3.1 Calculation of Sample Error Correction and Measurement Error

The meta-analysis study in this study found that the actual population correlation ($\rho$) after being corrected by the measurement error was estimated at 0.34 and the population variance [Var ($\rho$)] was 0.11 with a standard deviation (SD) of 0.33. Reference to the confidence interval $\alpha = 0.05$ with the acceptance limit between $-0.314 < \rho < 0.992$; and the value of $\rho$ is 0.34, then this value is included in the interval limit area to be accepted.

In addition to the above results, it was also found that the population correlation was corrected with the number of samples or $\hat{\rho}$ of 0.272, the correlation variance ($\sigma^2 $) was 0.075 with the deviasi standard (SD) of 0.333. With reference to the confidence interval $\alpha = 5\% = 0.05$ and the acceptance limit between $-0.342 < \hat{\rho} < 0.732$. Thus, it shows that the calculation result of $\hat{\rho} = 0.272$ is in the acceptance limit. Based on these results, it can be stated that the hypothesis of positive correlation between the student-centered learning model and learning outcomes is acceptable.

Other aspect that needs to be considered and to be carried out with a meta-analysis study regarding the relationship between the student-centered learning model and learning outcomes as the dependent variable are errors in sampling and errors in measurement. These two things show the following results,

a. Errors in sampling with the result that the sampling error variance value is 0.003 and the variance value in the population is 0.075. The variance value of sampling error compared to the population variance value multiplied by 100% shows that the percentage of variance caused by sampling error is small, namely 4.45%. This small percentage indicates the possibility of error bias due to small errors in sampling.

b. Error in measurement with the result of the variance value of measurement error in both of the independent variable and the dependent variable is 0.0000006. Meanwhile, the variance value of the population is 0.075. If the variance of measurement error is compared to the population variance, the percentage of variance caused by measurement error is small, namely 7.87%. It is smaller than the impact of sampling error. This small percentage indicates the possibility of error bias because errors in measurement are very small.

Based on these two things, it can be stated that all the final assignments sampled indicate that there were no mistakes in sampling, even though there were two final assignments with a small sample size (less than 20 students) but had met the minimum requirements for the number of samples. Secondly, it was assumed that there were no errors in measurements during the study. It means that the measuring instrument used to obtain data on learning outcomes is in accordance with its designation.

3.2 Determining the Value of Effect Size

Study of the effect size is carried out by finding the difference between the mean of the experimental class (using the student-centered learning model) and the mean of the control class (using teacher-centered learning). Then, it is divided by the standard deviation of the control class. The calculation results are presented in Table 3.

Table 3. Results of the calculation of the effect size of the reviewed thesis.

| Thesis | Average(Xe) | Average(Xc) | SD (Sp) | Effect Size (d) | Category |
|--------|-------------|-------------|---------|----------------|----------|
| 2019-01| 70.200      | 60.97       | 4.766   | 1.937          | High     |
| 2019-02| 52.65       | 49.08       | 3.78    | 0.944          | High     |
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The study of 22 final assignments showed the statistical analysis technique was still simple, namely the t test which produced the t value. The results of the study found that all t-count values were greater than t-table values at a significant level of 5%. The results of the compilation of the independent and dependent variables on the 22 thesis studied show the theoretical concept are clear and logical. This clarity and logic can be seen from the descriptions of the theories used in explaining the relationship between the independent variables (various student-centered learning models) and the dependent variable (learning outcomes in the cognitive domain). The explanation of the relationship between the research variables is presented in the sub-chapter of the framework for each thesis studied. However, the relationship between the research variables is not explored empirically in the discussion sub-chapters for each thesis studied. This is the weakness of some of the thesis that were used as research samples.

Comparison of the effectiveness of student-centered learning models with teacher-centered learning models on learning outcomes can be seen from the t value calculation of the statistical techniques used. The results of the study of the t value for all researched thesis show all t-count values are greater than t-value values at a significant level of 5%. It means the innovative learning model with the student-centered learning paradigm is superior to the teacher centered learning model for the learning outcome.

| Thesis | Average(Xe) | Average(Xc) | SD (Sp) | Effect Size (d) | Category |
|--------|-------------|-------------|---------|----------------|----------|
| 2019-03 | 69.89       | 63.55       | 4.005   | 1.583          | High     |
| 2019-04 | 35.58       | 31.11       | 6.821   | 0.655          | Medium   |
| 2019-05 | 80.9        | 78.9        | 4.119   | 0.476          | Medium   |
| 2019-06 | 79.33       | 72.44       | 5.36    | 1.285          | High     |
| 2019-07 | 90.95       | 83.75       | 13.158  | 0.547          | Medium   |
| 2019-08 | 36.97       | 32.55       | 6.45    | 0.689          | Medium   |
| 2019-09 | 77          | 66          | 7.69    | 1.43           | High     |
| 2019-10 | 67.7        | 57.53       | 8.476   | 1.2            | High     |
| 2019-11 | 62.07       | 52.7        | 7.193   | 1.303          | High     |
| 2019-12 | 77.6        | 57.5        | 15.787  | 1.273          | High     |
| 2019-13 | 51.03       | 45.18       | 3.83    | 1.527          | High     |
| 2019-14 | 85.07       | 65.6        | 15.89   | 1.225          | High     |
| 2019-15 | 75.142      | 59.573      | 7.169   | 2.172          | High     |
| 2019-16 | 36.13       | 26.47       | 8.41    | 1.149          | High     |
| 2019-17 | 76.12       | 70.36       | 2.21    | 2.606          | High     |
| 2019-18 | 76.9        | 69.7        | 10.3    | 0.699          | Medium   |
| 2019-19 | 76.5        | 67.52       | 11.235  | 0.799          | Medium   |
| 2019-20 | 67.86       | 62.88       | 3.73    | 1.335          | High     |
| 2019-21 | 77.7        | 69.1        | 9       | 0.956          | High     |
| 2019-22 | 77.45       | 73.82       | 6.86    | 0.529          | Medium   |
| Average | 62.25       | 57.23       | 7.231   | 1.109          | High     |

Xe = experiment group; Xc = control group; SD(Sp) = Standard deviation of the control group;

Based on Table 3, with reference to the categories according to Cohen (1988), 7 theses (31.82%) have medium effect size and 15 theses (68.18%) have high category effect size. The effect size value for the entire sample is 1.109 in the high category. It means the independent variable (student-centered learning) under study tends to have a large effect size.

3.3 The relationship between variables and the comparison of the effectiveness of the learning model used in the thesis under study.

The study of 22 final assignments showed the statistical analysis technique was still simple, namely the t test which produced the t value. The results of the study found that all t-count values were greater than t-table values at a significant level of 5%. The results of the compilation of the independent and dependent variables on the 22 thesis studied show the theoretical concept are clear and logical. This clarity and logic can be seen from the descriptions of the theories used in explaining the relationship between the independent variables (various student-centered learning models) and the dependent variable (learning outcomes in the cognitive domain). The explanation of the relationship between the research variables is presented in the sub-chapter of the framework for each thesis studied. However, the relationship between the research variables is not explored empirically in the discussion sub-chapters for each thesis studied. This is the weakness of some of the thesis that were used as research samples.
variables studied. Learning outcomes which are used as the dependent sample vary in terms of terms, namely there are some using learning achievement, there are learning outcomes, there are critical thinking skills and there are performance skills.

Statistically, it shows that student-centered learning models are more effective than teacher-centered learning models in facilitating student learning activities to achieve the learning outcomes studied. Even so, the results of the study of the 22 thesis sampled still have weaknesses. Broadly speaking, these weaknesses can be described as follows,

1. There has not been a more in-depth description of critical arguments based on empirical studies regarding the advantages of student-centered learning models.
2. There is no description of the theoretical and empirical justification regarding the syntax of the student-centered learning models so that they can improve the learning outcomes studied (there is no explanation for each syntax of the learning model with learning activities that play a role and have a direct effect on the achievement of learning outcomes).
3. There is still a lack of in-depth theoretical arguments regarding the difference in the influence of the variables used, which are associated with the achievement of better learning outcomes.
4. There is no in-depth, critical and logical analysis / explanation of the variables’ meaning that appear as the effect of the learning model used on the learning outcomes studied.

Based on a meta-analysis study applied, it was found that the magnitude of the sampling error was in the small category. It can be seen from the heterogeneity of the samples used in the study. As can be seen from the characteristics of the sample, this study involved research subjects from early childhood education students, junior high school students, high school students, and vocational high school students on the same field, namely ICT. There is diversity in terms of thinking between these subjects due to differences in levels of cognitive development at each different age stage [16] [17]. The varying levels of cognitive development can have an impact on the effectiveness of the syntax implementation of the student-centered learning models used. Innovative adaptations need to be made in the syntax implementation of student-centered learning models. Then, the types of studies involved as material for meta-analysis are all experimental studies with a very varied number of research subjects. The range of the subject number involved in each study was 15 to 42 students per treatment cell. The imbalance or variation in the number of subjects in this experimental study can have an impact on the correlation variance to the estimated correlation variance and confidence interval [14].

There were more effect sizes in the medium category in the thesis that used the cooperative learning model, but overall showed a high effect size (d), which was 1.109 (d > 0.8 was high). It means that the magnitude of the effect by the parameters tested (student-centered learning models) is high on the measured learning outcomes.

The magnitude of the effect on the learning outcomes under study must be justified. The justification is in the form of theoretical and empirical logical study of the relationship between variables. This is the weakness of some of the thesis that were used as research samples. Conceptually, the theoretical models of student-centered learning are based on constructivist learning theory. The syntax of the student-centered learning model has five elements of constructivist learning, namely (i) activating existing knowledge; (ii) acquiring new knowledge by studying it as a whole, then paying attention to the details; (iii) understanding knowledge through formulating hypotheses, sharing, revising, and developing concepts; (iv) practicing knowledge and skills (applying knowledge); and (v) reflecting knowledge.

The syntax of the student-centered learning model requires the involvement of the learner's mind, in the form of thinking skills in the learning process. Students are expected to be fully involved in striving for an effective learning process, taking responsibility for the occurrence of an effective learning process, and bringing their respective schemata into the learning process. The activities of learners in learning are based on intrinsic motivation. In this case, the learner will behave well because he/she believes that it is the best and useful.
3.4 Conditions Affecting the Effectiveness of Student Centered Learning Models.

The purpose of conducting a meta-analysis is to analyze data from the primary study. The results of the analysis are used as the basis for accepting (supporting) the hypothesis or rejecting (invalidating the hypothesis) and providing specific instructions for further research [18]. Referring to the results of the meta-analysis study, data analysis of the student-centered learning model on learning outcomes shows that the hypothesis of the differences in learning outcomes between groups of students facilitated with student-centered learning and teacher-centered learning models is acceptable. In other words, student-centered learning models are more effective in achieving the learning outcomes under study. There are several conditions that influence the effectiveness of these models.

A study of all the final assignments used as research samples revealed that there were three conditions that made the student-centered learning model more effective. The three conditions are (1) the existence of modeling (modeling); (2) training (coaching); and (3) the presence of scaffolding. Modeling involves behavior modeling activities to encourage performance development and cognitive modeling to encourage cognitive processes. Coaching, which involves providing motivation, monitoring and regulating student activities, and encouraging students to reflect themselves. Scaffolding, concerning the activities of providing support / assistance temporally according to the capacity of the learners' abilities. Therefore scaffolding also includes determining the level of difficulty of the task, restructuring tasks, and providing alternative assessments.

Student-centered learning models direct students to learn to think in the context of scientific process skills. Therefore, in general all the syntax that characterizes the models used in the study stimulates the creation of effective learning conditions. The learning conditions are, (1) emphasizing problem solving; (2) recognizing the need for learning that occurs in contexts, such as in the home, community and work environment; (3) teaching students to monitor and direct their own learning (becoming independent learners); (4) linking teaching to different contexts of student life; and (5) encouraging students to learn from peers (peer tutors) and learning together (collaboration).

4. Conclusion

The overall calculation of all the final assignments used as the meta-analysis sample shows the effect size (d) is high, which is 1.109 (d> 0.8; including the high criteria). It means the magnitude of the effect caused by the parameters tested (student-centered learning model) is high on the measured learning outcomes. The empirical study shows that the implementation of the stages (syntax) of the student-centered learning models has five constructive learning elements, namely (1) activating existing knowledge (activating knowledge); (2) acquiring new knowledge (acquiring knowledge) by studying it as a whole, then paying attention to the details; (3) understanding knowledge through formulating hypotheses, sharing, revising, and developing concepts; (4) practicing knowledge and skills (applying knowledge); and (5) reflecting knowledge.

Student-centered learning models are more effective for the achievement of the learning outcomes studied. There are three conditions that make student-centered learning models more effective. The three conditions are, (1) the existence of modeling; (2) training (coaching); and (3) the presence of scaffolding. Modeling involves behavior modeling activities to encourage performance development and cognitive modeling to encourage cognitive processes. Coaching, which involves providing motivation, monitoring and regulating student activities, and encouraging students to reflect themselves. Scaffolding, concerning the activities of providing support / assistance temporally according to the capacity of the learners' abilities. Therefore scaffolding also includes determining the level of difficulty of the task, restructuring tasks, and providing alternative assessments.

Reference

[1] Agustini K, Santyasa I W and Ratminingsih N M 2019 Analysis of Competence on “TPACK”: 21st Century Teacher Professional Development Journal of Physics: Conference Series 1387 1-9

[2] Salza P 2019 Agile and Lean Concepts for Teaching and Learning Agile and Lean Concepts for
Teaching and Learning

[3] Alegre F, Moliner L, Maroto A and Lorenzo-Valentin G 2019 Peer tutoring and mathematics in secondary education: literature review, effect sizes, moderators, and implications for practice *Heliyon* **5** e02491

[4] Bale C and Archer J 2013 Self-perceived attractiveness, romantic desirability and self-esteem: A mating sociometer perspective *Evolutionary Psychology*

[5] Wahyuni D S, Agustini K, Sindu I G P and Sugihartini N 2020 Analysis on vocational high school teacher competency gaps: Implication for VHS teacher training needs *Journal of Physics: Conference Series* **1516** (Institute of Physics Publishing)

[6] Darnanta I W, Pradnyana I M A and Agustini K 2020 Development of mathematics interactive learning media with gamification concept for mentally disabled students *Journal of Physics: Conference Series* **1516** (Institute of Physics Publishing)

[7] Matthew J K, Mirsha P, Kereluik K and Shin T S and Graham C R 2014 The Technological Pedagogical Content Knowledge Framework *Handbook of Research on Educational Communications and Technology: Fourth Edition* 347–248

[8] Forehand M 2020 Emerging Perspectives on Learning, Teaching and Technology *Handbook 1: Cognitive domain*

[9] Valencia-vallejo N, Nacional U P, López-vargas O, Nacional U P, Sanabria-rodríguez L and Nacional U P 2006 E-Learning Environments: Self-Efficacy, Learning Achievement, and Cognitive Style

[10] Sutiarso S and Coesamin M 2018 The Effect of Various Media Scaffolding on Increasing Understanding of Students’ Geometry Concepts **9** 95–102

[11] Chiang C L and Lee H 2016 The Effect of Project-Based Learning on Learning Motivation and Problem-Solving Ability of Vocational High School Students *International Journal of Information and Education Technology* **6** 709–12

[12] Elen J and Bishop M J 2014 General instructional strategies *Handbook of Research on Educational Communications and Technology: Fourth Edition* 347–248

[13] Fritz C O, Morris P E and Richler J J 2012 Effect size estimates: Current use, calculations, and interpretation *Journal of Experimental Psychology: General*

[14] Schmidt F L 2015 History and development of the Schmidt-Hunter meta-analysis methods *Research Synthesis Methods*

[15] Papanikolaou K, Makri K and Roussos P 2017 Learning design as a vehicle for developing TPACK in blended teacher training on technology enhanced learning

[16] Sokol B W and Hammond S I 2009 Piaget and affectivity *The Cambridge Companion to Piaget*

[17] Ackermann E 2012 *Piaget’s Constructivism, Papert’s Constructionism : What’s the difference?*

[18] Agustini K, Darmawiguna, Artayasa I G M and Mertayasa I K D 2020 Evaluation of the Teachers’ Acceptance to E-Report Card Applications with the Hot-Fit Model Approach **13**