Designing and validating an instrument to measure the practicality of the research-based blended flipped learning model

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ABSTRACT: Measuring the practicality of learning models as an educational intervention with an experimental design requires valid, reliable and practical instruments. The aim of this study was to construct such an instrument. The main inputs were a literature review and the experience gained from designing and validating instruments to measure the impact of educational interventions. The constructed instrument was assessed by experts. Data was analysed with the Aiken validity formula. The main steps in the process, including the instrument item construction, expert assessment and the instrument's trial are presented in this article. Outcome learning measurement is also mentioned. The key considerations and reasons for measuring educational activity are discussed. Methods for creating new instruments are offered. It is hoped that this study can assist other researchers in developing valid, reliable and practical instruments for measuring the process of educational activity.

INTRODUCTION

Teachers' research competence is important and must be developed for the following reasons: 1) the demands of modern society for professionals who can work in a variety of settings [1]; and 2) to ensure the integrity and continuity of competitiveness as a process of forming subject teachers, integrating research and professional activities [2].

Many strategy efforts and models are used to develop research competencies. They include the use of the principles of the following models: the attention, relevance, confidence, and satisfaction (ARCS) development model in motivation [3]; the ASSURE model which is an acronym referring to the necessity of analysing learners (A), stating objectives (S), selecting methods, media and materials (S), utilising them (U), to the requirement of learner performance (R), and evaluation and revision of the educational process (E), also audience engagement and collaborative research are needed to achieve training objectives [4]; structural-functional model for the formation of research competencies of prospective teachers [5]; development model with the conceptual basis of systemic, personality-oriented, activity-based, cognitive, heuristic and axiological approaches [6]; functional model as a component of the concept of research training [7] and others. However, based on the literature search conducted by the authors, there is a paucity of coverage in regard to research-based blended flipped learning models to improve prospective teacher students' research competence.

The research-based blended flipped learning (RBBFL) is one of the learning models. This model was developed based on research-based, blended and flipped learning theories and packaged from a heutagogy perspective. The heutagogy perspective underlies each step in the RBBFL model. In some learning situations, the learner's objectives and preferred methods of learning should be the focus of attention. The learner takes on more of a role of a facilitator or guide on how the desired learning can occur. First, there must be a recognition that learning is necessary, and then the learner helps determine the appropriate assessment tool. Heutagogy is also known as self-determined learning [8-11]. E-learning significantly affects self-regulated learning (SRL), while self-regulated learning significantly affects the self-determined one [12]. Self-regulated learning is crucial to uphold learning and assess creative, critical thinking. It can encourage students' success in learning engineering [13].

Research-based learning is a systematic learning activity for students to build their understanding and knowledge [14][15]. It is a type of learning activity that develops core competencies, such as broad knowledge orientation, systemic/network thinking, divergent thinking, creativity, methodological flexibility, resilience, broad-mindedness, tolerance, as well as communication, co-operation, work capacity, assertiveness and responsibility [16].

Blended learning, which combines on-line face-to-face instruction, can provide significant assistance in developing student research competencies and critical thinking skills [17-19]. Web-based instruction learning, through learning management systems, such as Edmodo, can solve student learning problems related to place and time, and is efficient in learning [20].

Factors that influence the effectiveness of on-line learning include the ease of use, overall usability, learners' attitude towards usage, satisfaction, behaviour to use, self-efficacy, attitudes of lecturers and teaching methods [21]. On-line learners appreciate the ease of access, time spent and learning materials that match the opportunities created by lecturers, the exchange of questions, opinions and responses, interaction and being actively involved in the learning process [20]. Blended or hybrid, student-centred educational models can improve student learning experiences and outcomes [22].

The flipped classroom is a learning model in which students watch videos or listen to recordings of lectures at home, and receive assignments and are directed to learning sources that must be thoroughly prepared and then discussed in class meetings. When students come to class, the teacher facilitates group work or other learning activities [19][23][24]. Students can access, use and benefit from video lectures to keep them informed and progress with their learning [25]. The flipped mastery social media-assisted classroom model improves student performance by making learning more flexible, interactive and productive [26].

Based on the theory of research-based learning, blended learning, flipped learning and the theory of heutagogy, the structure and working steps of the research-based blended flipped learning model were developed. The structure of the RBBFL model is shown in Figure 1.

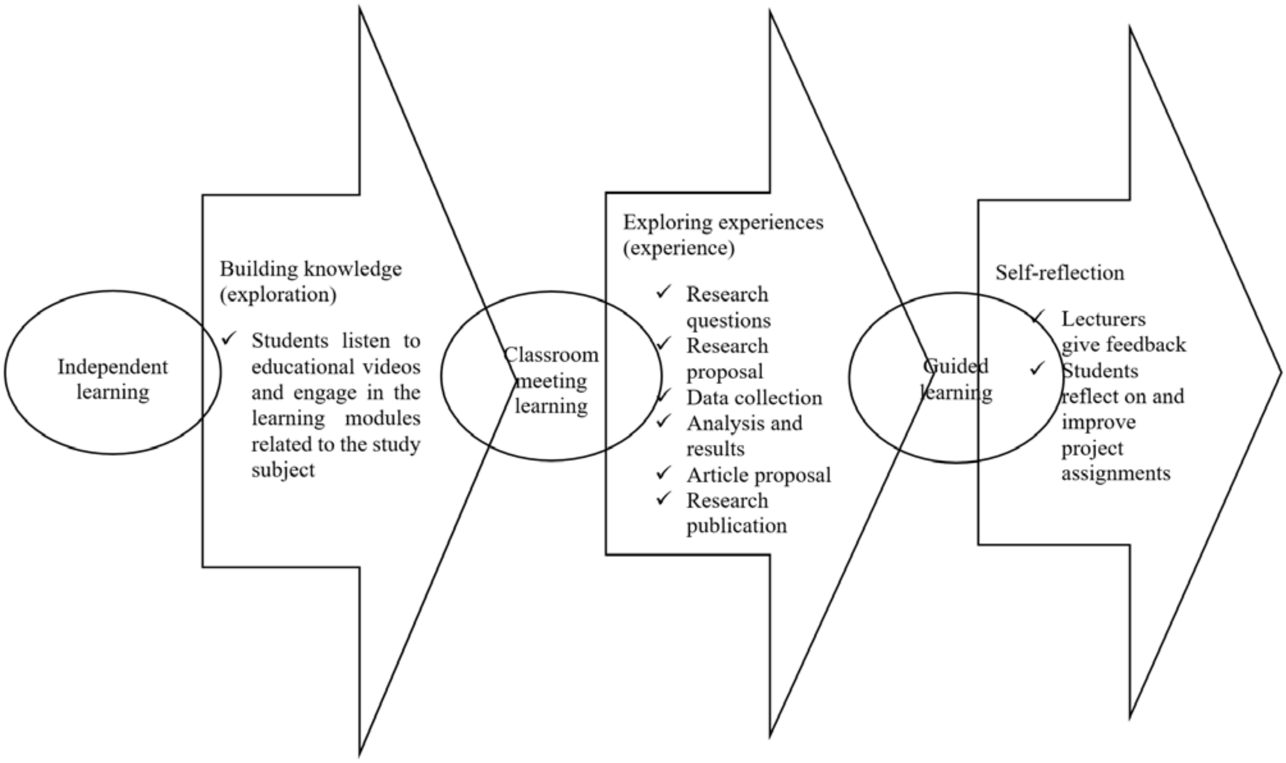

Figure 1: Structure of the research-based blended flipped learning (adapted from research-based, blended and flipped learning theories).

The RBBFL learning model is intended to help develop research competencies. Thus, it is crucial to properly and continuously measure the practicality of implementing the RBBFL learning model to improve the mastery of pre-service teachers' research knowledge. This was undertaken in regard to a research methodology course within the building engineering education study programme in one of the universities in Indonesia.

Practicality indicators include five components:

1) expanding resources and class references;
2) improving work processes and products;
3) fostering more independent student activities;
4) mediating the thinking and learning of the subject;
5) increasing student motivation towards the lesson [27].

A key aspect that affects the practicality value is the ease of use [28], and also the aspect of feelings the pleasure towards the learning component, aspect of feelings the novelty in learning and the aspects of interest in learning [29]. Regarding the practicality of applying the RBBFL learning model, educators need to think about moving the relevant theory to the teaching practice [30].

This study outlined in this article aims to: 1) determine the quality of the practicality of the RBBFL learning model; and 2) test the psychometric validity of the practicality of the RBBFL learning model.

MATERIALS AND METHODS

This study includes development of an instrument and is based and builds on previous research [31][32]. The instrument developed is a self-evaluation instrument. The stages are: 1) construction of instrument items; 2) expert assessment; and 3) instrument trials.

Instrument Item Construction

The first stage in constructing instrument items is a literature review. The review allowed to obtain indicators measuring the practicality of the learning process. Next, these indicators were developed into statements. As mentioned above, five components were identified based on earlier research [27]. The instrument was designed using a four-point Likert scale; namely: 1- strongly disagree, 2 - disagree, 3 - agree and 4 - strongly agree [33].

Expert Team

Five educational evaluation experts carried out instrument validation. The experts are lecturers holding a doctorate. The experts validated the self-evaluation instrument's practicality using the Likert scale of 1 to 5, from highly irrelevant to highly relevant.

Participants

Participants for the trial were selected with a purposive sampling technique [34]. In this sampling, 60 students were recruited from the building engineering education study programme at one of the universities in Indonesia. There were 38.3% male and 61.7% female students in the trial.

Data Collection and Analysis

The research data were collected using on-line questionnaires. WhatsApp was used to communicate with the participants. Then, the participants were asked to access the relevant Web page and complete the questionnaire [35][36].

Expert validity was carried out using the Aiken validity formula [37][38]. Then, the validity of the data from the questionnaire trial results was calculated using the product-moment correlation [39]. Finally, reliability was calculated with Cronbach's alpha [40].

Calculation of Aiken validity (V) - Formula 1 and Formula 2.

$$V = s/[n(c-1)] \qquad (1)$$

$$s = r - lo \qquad (2)$$

Note:

V = Aiken validity coefficient
lo = lowest number of validity assessments = 1
c = highest validity assessment score = 5
n = number of experts = 5
r = figures given by experts.

The statement's validity is declared valid if the value of the calculated V is greater than the value of Aiken V from the table.

The calculation of the validity of the questionnaire of the trial results was carried out by checking the product-moment (r) value of the calculation results and the product-moment value of the table. Determination of the value of the product-moment (r) table was based on the number of respondents.

The basis for decision making in the validity test of the question items can be accomplished in different ways; namely:

- Comparing the calculated r value with the table r value. If the value of the r count is greater than the r in the table, then the item of the questionnaire question is declared valid; if the r count is smaller than the r in the table, then the item of the questionnaire question is declared invalid.
- Comparing Sig. values (2-tailed) with a probability of 0.05. If the value of Sig. (2-tailed) is less than 0.05 and the Pearson correlation is positive, then the item in the questionnaire is valid. If the Sig. (2-tailed) value is less than 0.05 and the Pearson correlation is negative, the item in the questionnaire is invalid, and if the value of Sig. (2-tailed) is greater than 0.05, then the item in the questionnaire is invalid.

Reliability testing can be carried out jointly on all or selected question items in the questionnaire. The basis for decision making in the reliability test is as follows: if the value of Cronbach's alpha is greater than 0.60, then the question or questionnaire is declared reliable or consistent. Conversely, if the value of Cronbach's alpha is smaller than 0.60, the questionnaire is declared unreliable or inconsistent.

RESULTS AND DISCUSSION

Instrument Item Construction

The instrument was designed based on indicators measuring the practicality of the learning process. These indicators were developed into statements. The practicality indicators were already mentioned and were based on earlier research [27]. The instrument consists of 28 questions to measure the practicality of the learning process with the RBBFL model in the research methodology course. The indicators and statement items are included in Table 1.

Table 1: Indicators and statement items in the questionnaire.

	Indicators and statement items
A	Expending resources and class references
	In my opinion, the teaching material has been completed with video tutorials in the LMS Spada. I think an example of a task has been described in the LMS Spada. I think there is a learning strategy guide for each material topic in the LMS Spada. In my opinion, there is a team of teaching lecturers.
B	Improving work processes and products
	In compiling the proposal, I read many publications to determine the topic. In compiling the proposal, I chose one paper to be a text guide in my research. In compiling the proposal, I learned how to use research-related technologies, such as Google Scholar, digital library, Tandfonline, etc. The document translator application helps me in understanding foreign articles. Video tutorials helped me in putting together a proposal. The proposal I made is based on current issues. The proposal I made is based on many library sources that I had read. The references in the proposal I made are mostly sources from national and international journals. My proposal includes numerous international references.
C	Fostering more independent student activity
	I read the material that was provided in the LMS Spada before classes. I studied the learning videos provided in the LMS Spada. I always try to work on the task of each material. I always read the study strategy guide in the LMS Spada.
D	Mediating the thinking and learning of the subject
	Video tutorials helped me in learning research methods. Google Scholar helps me in finding references. International journals help me in finding references. National journals help me in finding references. The digital library helps me in finding references. The document translator helps me in translating foreign language papers. Open knowledge maps help me in finding research ideas.
E	Increasing student motivation towards the lesson
	I always attend lectures. I participated in asking the lecturer during classes. I participated in a group discussion in a breakout room on the Zoom platform while in the college. I always work on the task of each material.

Expert Appraisal

In the instrument's test results from the learning evaluation experts the formulation of Aiken V was implemented as shown in Formula 1 and Formula 2. The calculation results of the value of V is presented in Table 2.

Table 2: Aiken's values from the expert assessment.

Item	Aiken's value (V)	Item's qualification
1	0.95	Valid
2	0.9	Valid
3	0.95	Valid

4	0.9	Valid
5	0.85	Valid
6	0.85	Valid
7	0.85	Valid
8	0.9	Valid
9	0.85	Valid
10	0.8	Valid
11	0.85	Valid
12	0.9	Valid
13	0.85	Valid
14	0.9	Valid
15	0.8	Valid
16	0.8	Valid
17	0.9	Valid
18	0.9	Valid
19	0.85	Valid
20	0.85	Valid
21	0.9	Valid
22	0.85	Valid
23	0.85	Valid
24	0.85	Valid
25	0.85	Valid
26	0.9	Valid
27	0.8	Valid
28	0.85	Valid

Based on the Aiken formula, the item is declared valid if the value of V is greater than the value of the V Aiken from the Aiken V table. In this study, the V value in the table was obtained based on the number of experts involved in validating. As there were five experts, so the V value obtained in the table is at 0.8. The index validity value (V) of the count of each obtained statement item is valued at or more than 0.8, so it was concluded that the question items were all valid.

Instrument Trials

After the instruments had been validated for content by the five experts, it was prepared for trials in order to measure the practicality of its implementation. There were 60 students involved in the trials. The results of the instrument's trials were calculated for validity and reliability. Data validity was calculated using a product-moment correlation [39]. Reliability was calculated with Cronbach's alpha [40]. The results of the development and validity of the instrument according to each indicator are presented in Table 3 to Table 7.

Table 3: Instrument validation in regard to *Expending resources and class references*.

Statements	Pearson correlation and Sig. (2-tailed)	Cronbach's alpha
The teaching materials have been completed with video tutorials in the LMS Spada.	0.471 0.000	0.944
An example task has been described in the LMS Spada.	0.559 0.000	0.943
There is a study strategy guide for each material topic in the LMS Spada.	0.555 0.000	0.943
There is a team of teaching lecturers.	0.469 0.000	0.944

Table 4: Instrument validation in regard to *Improving work processes and products*.

Statements	Pearson correlation and Sig. (2-tailed)	Cronbach's alpha
In compiling the proposal, I read many publications to determine the topic.	0.535 0.000	0.944
In compiling the proposal, I chose one paper to be a text guide in my research.	0.424 0.001	0.945
In compiling the proposal, I learned how to use research-related technologies, such as Google Scholar, digital library, Tandfonline, etc.	0.721 0.000	0.942

The document translator application helps me in understanding foreign articles.	0.678 0.000	0.942
Video tutorials helped me in putting together a proposal.	0.772 0.000	0.941
The proposal I made are based on current issues.	0.766 0.000	0.941
The proposal I made is based on many library sources that I had read.	0.799 0.000	0.941
The references in the proposal I made are mostly sources from national and international journals.	0.617 0.000	0.943
My proposal includes numerous international references.	0.703 0.000	0.942

Table 5: Instrument validation in regard to *Encouraging more independent student activity*.

Statements	Pearson correlation and Sig. (2-tailed)	Cronbach's alpha
I read the material that was provided in the LMS Spada before classes.	0.777 0.000	0.941
I studied the learning videos provided in the LMS Spada.	0.728 0.000	0.941
I always try to work on the task of each material.	0.647 0.000	0.942
I always read the study strategy guide in the LMS Spada.	0.702 0.000	0.942

Table 6: Instrument validation in regard to *Mediating the thinking and learning of the subject*.

Statements	Pearson correlation and Sig. (2-tailed)	Cronbach's alpha
Video tutorials helped me in learning research methods.	0.739 0.000	0.941
Google Scholar helps me in finding references.	0.519 0.000	0.944
International journals help me in finding references.	0.630 0.000	0.943
National journals help me in finding references.	0.635 0.000	0.943
The digital library helps me in finding references.	0.553 0.000	0.943
The document translator helps me in translating foreign language papers.	0.641 0.000	0.943
Open knowledge maps help me in finding research ideas.	0.714 0.000	0.942

Table 7: Instrument validation in regard to *Increasing student motivation toward learning*.

Statements	Pearson correlation and Sig. (2-tailed)	Cronbach's alpha
I always attend lectures.	0.481 0.000	0.944
I participated in asking the lecturer during classes.	0.655 0.000	0.943
I participated in a group discussion in a breakout room on the Zoom platform while in the college.	0.712 0.000	0.942
I always work on the task of each material.	0.559 0.000	0.944

From the table product-moment (r) and with 60 participants (N), the value of (r) obtained was 0.254. The basis for making decisions in this test can be deployed in a number of ways. For example, if the calculated r value in all items is greater than the r table, then the questionnaire item is declared valid. If the Sig. (2-tailed) value with a probability of 0.05 in all items is smaller than 0.05 and the Pearson correlation is positive, the item in the questionnaire is valid. If Cronbach's alpha results in all items are greater than 0.60 in the reliability test, then the questionnaire is declared reliable or consistent.

The results of this study on the development of an instrument to measure the practicality of the RBBFL learning model, which focused specifically on the research methodology course within the building engineering education study programme, can be adopted as a tool in evaluating the learning process according to the context of each field of study. By implementing the RBBFL model in the research methodology course, students can improve their learning performance and learning motivation. Through the application of flipped learning and heutagogy theory, students can learn independently in building research knowledge [25].

Within the RBBFL model, students watch videos in the learning management system as source material for planning research topics. In the face-to-face stage in class, they can explore various sources of knowledge and experience researching through navigation and analysis of journals and other documents in preparation of resources for their research proposals. Lecturers provide feedback on the projects completed by students, while students reflect on the projects' results. This model appears essential for enforcing creative critical thinking, learning and assessment [12].

CONCLUSIONS

In this study, a tool was developed that can measure the practicality of a research-based blended flipped learning model in relation to the research methodology course within the building engineering education study programme at one of the universities in Indonesia. Based on the literature review, it was established that the main factors affecting the success of practicality are:

1) expanding resources and class references;
2) improving work processes and products;
3) fostering more independent student activities;
4) mediating the thinking and learning of the subject;
5) increasing student motivation towards the lesson.

The instrument measuring the practicality of the RBBFL model was developed and sufficient evidence was gathered regarding its content validity and reliability. The tool developed in this study can be used for evaluating the learning process and can be adjusted to the context of other fields, other than research methodology in building engineering education. The limitations of this study refer to selecting only one university; however, future studies can include more universities to create a more balanced sample in one country.

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