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by M. Haviz

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Development of Research-Based Learning Model in Biology Education: What is Relevance, Concystency and Practicality?

M. Haviz*
IAIN Batusangkar

Abstract

The purpose of this article is to design a consistent research-based learning model and internal relevance on biology learning at Higher Education. The study participants were 88 students of Biology Education Department IAIN Batusangkar who studied Research Method subjects in Biology study, academic year 2016/2017. The method used was educational design research with preliminary stages of research, prototyping stage, and assessment stage. The instruments used were product assessment sheets and achievement test. Preliminary research findings were analysed by reducing, presenting, and drawing conclusions. The mean score of formative evaluation result and average score of the students' achievement were analysed by descriptive statistic. Preliminary research results showed that changes should be made toward the biology learning outcomes. The next finding was that there were 9 supporting theories used to design research-based learning models on biology learning. Formative and summative prototype evaluation results were good and had met the criteria of developing the learning model. So, it was concluded that research-based learning model on biology learning had consistency and internal relevance.

Key words: consistency, internal relevance, practicalitiy, research-based learning model, biology learning

* M, Haviz, Doctor of Science education, Department of Tadris Biology in Insititut Agama Islam Negeri (IAIN) Batusangkar, 27213, Indonesia. Email: mhaviz@iainbatusangkar.ac.id

INTRODUCTION

Learning in Higher Education at Indonesia should refer and apply the Indonesian National Qualification Framework-Based Learning. The Indonesian National Qualification Framework-based learning requires students to master a certain level of competence. At the undergraduate level, competencies that must be mastered by graduates are at level 7 (Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 73 year 2013). To meet this qualification, educators must make changes to the instructional design. The changes in instructional design will affect the learning environment (Choi & Hannafin, 1995) including changes in the way of learning / teaching in the classroom. The use of specific learning models is assumed to be able to overcome various problems in learning (Isman, 2011).

The application of learning models is an important aspect to support biology learning (Krell & Krüger, 2016). The application of this model is done to test the students' understanding of the applied model (Grünkorn, Belzen, & Kruger, 2014) and to equip students with 21st century competencies (Greenstein, 2012). This condition requires instructional design intervention on biology learning (Janssen & Waarlo, 2010).

The interventions of instructional design and change of teaching/learning at Higher Education are assumed to be undertaken by developing research-based learning models. Research-based learning on biology learning is conducted by applying scientific research and research practice (Joyce, Weil, & Calhoun, 2009) aimed at reducing the distance between theory and practice (Vanderlinde & Braak, 2010). Both ways of learning are examples of

curriculum development and teaching strategies. The scientific research and research practice are conducted by teachers to develop scientific experiences by designing new learning environments (Stuessy & Metty, 2007) and using collaborative designs on lesson plans (Roblin, Ormel, McKenney, Voogt, & Pieter, 2014), integrative learning models (Haviz, Lufri, Fauzan, & Efendi, 2012), and laboratory practical exercises (Osuafor & Amaefuna, 2016).

When the learning model is designed, the researcher takes into account the components of the learning model such as syntax, reaction principles, social systems, support systems and impact learning (Joyce & Weil, 1992). The researcher also pays attention to the instructional development process as well. Instructional development can be done by adapting (Park & Lee, 2002) or applying an existing learning model. The development of instructional design on biological learning should be followed by evaluation (Ummels, Kamp, Kroon, & Boersma, 2015) and then tested to determine how it influences in learning (Koksal, Cakiroglu, & Geban, 2013).

The quality of instructional models in educational design research is determined by internal relevance and consistency aspects (Nieeven, 2010). Both aspects are determined by the initial identification process (Richey, Klein, & Nelson, 2002), design, assessment, and revision. Formative evaluations are conducted in prototypes that have been designed to reflect the degree of product resistance toward revision (Tessmer, 1993) while documentations and systematic reflections are made in the final stages (Plomp, 2010). The internal relevance and consistency aspect of educational design research are also determined by the level of expectation degree toward the research findings (reality) (Nieeven, 2010). The expectation of the results of the research toward the expected reality is proved by a series of tests such as self and expert review and used in small or large group test (Tessmer, 1993).

In this study, the researcher designed a learning model based on the learning model components written by Joyce & Weil (1992). In this study, the relevance and internal consistency of the prototype of a research-designed learning model refers to the relevance aspects and consistency that have been written by Nieeven (2010) and Tessmer (1993). The research question was 'how is the relevance and internal consistency in the development of research-based learning models on biology learning?' The purpose of this article was to design a consistent research-based learning model and internal relevance in biology learning.

Research Method

Research Participants

The participants of this study were 88 students of Biology Education Department IAIN Batusangkar who studied Research Method subjects in Biology study, academic year 2016/2017. After conducting characteristic analysis, the participants were divided into three classes or groups of study that were class A = 32 students, class B = 28 students, and class C = 28 students.

Research procedure

This research was an educational design research consisting of phases: preliminary research, prototyping, and assessment (Plomp, 2010; Haviz, 2013). In preliminary research, the researcher conducted an in-depth analysis of the issues associated with the framework based on the literature review. In the prototyping stage, the researcher designed the initial reference frame and the prototype. These activities were cyclical, and divided into three forms: design, formative evaluation, and revision. In the stage assessment, the researcher conducted a summative evaluation in the classroom for 6 meetings.

Instruments and Data Analysis Techniques

The research instruments used in this study were assessment sheets and achievement test. Preliminary research findings were analysed using Miles and Huberman techniques, namely reduction, presentation, and conclusion. The average score of formative and summative evaluation result in the form of the students' achievement of learning outcomes were analysed by descriptive statistics (Gay, Mills, & Airasian, 2009). Product quality was determined from the aspect of relevance and internal consistency (Nieveen, 2010; Tessmer, 1993).

Results and Discussion

The results of the preliminary stage showed that there should be changes in the learning outcomes. These changes lead to the students' competence changes in learning Research Methods in biological study. The main competencies that will be achieved after this learning process: the students are able to understand the concept of research and able to write research proposals and reports in the field of biology learning. To support the main competency goals, nine supporting competencies are required. They are (1) The students are able to explain the relationship of philosophy, research, and education; (2) The students are able to explain the basic concepts of educational research; (3) The students are able to find and select research topics; (4) The students are able to make research plan; (5) The students are able to explain how to select the research sample; (6) The students are able to design research instruments; (7) The students are able to understand, select, and conduct selected research from Descriptive Research, Correlational Research, Causal-Comparative Research, Experimental Research, Single-Subject Experiment, and Research Development (8) The students are able to analyse and interpret data of research result with Descriptive Statistics and Inferential Statistics, and (9) The students are able to write proposal, research report, and article to be published in scientific journal.

The research findings on relevant research theories and concepts used to complete the proto-titles were listed in Table 1. The prototype design matrices were written in Table 2 and the logical framework was shown in Figure 1. Table 1 drew that there are 9 theories/concepts used to design research-based learning model prototype in biology learning. In Table 2 and 3 the components of research-based learning models, such as development stage, construction, and model characteristics were presented. In Figure 1, there were 5 components of the model: syntax, reaction principle, social system and support system, instructional and nurturant impact.

Table 1 Theory/concept of development of research-based learning model on biology learning

No		theories/concepts	Authors
1	theory of learning	*Cognitivism*	(Ertmer & Newby, 2013)
		Constructivism	
		Behaviorism	
2	Construction of model	Syntax	(Joyce & Weil, 1992)
		principle of reaction	
		system social	
		supporting system	
		instructional and nurturing effect	
3	integrative model as a base of Indonesia qualification framework	construction of model	(Haviz, Lufri, Fauzan, & Efendi, 2012)
		modern instructional	(Suparman, 2012)
		Indonesian qualification framework	(Direktorat Jenderal Pendidikan Tinggi, 2011)
		Integrative approach	(Drake & Burns, 2004)
4	model based research	scientific research model	(Joyce, Weil, & Calhoun, 2009)
5	design research and instructional design	*Educational design research*	(Plomp, 2010)
6	Content	educational research	(Gay, Mills, & Airasian, 2009)

Table 2 Prototype matrix of research-based learning model on biology learning

No	Educational Design Research		model research training: model research training: from fact to theory	Construction of Model	Behaviourism, Cognitivist, Constructivism	curriculum based competency and Indonesia Qualification Framework	Adaptive Instructional System	Material of Research
1	Preliminary Research	characteristic of instructional	•	•	•	•	•	•
2	Prototype Stage	design prototype	•	•	•	•	•	•
		formative evaluation	•	•	•	•	•	•
		Revision	•	•	•	•	•	•
3	Assessment *Stage*	summative evaluation	•	•	•	•	•	•

Note: Abs (•) show the component on matrix

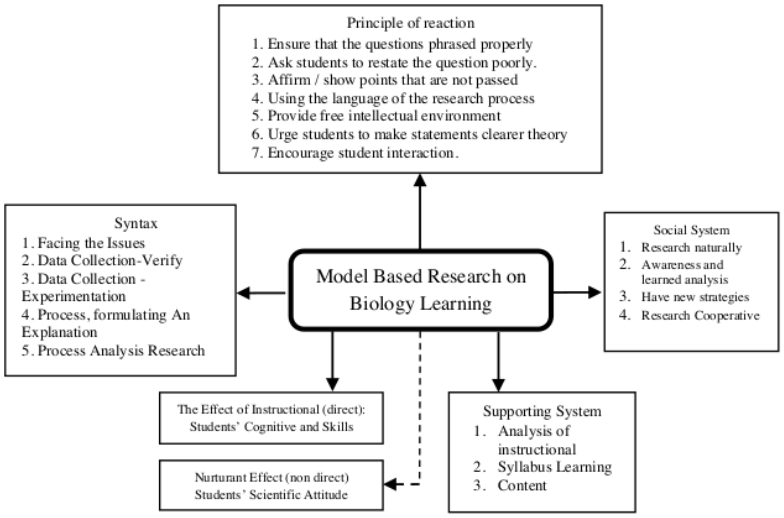

Figure 1 Logical framework model of research-based learning on biology learning

Formative evaluation results were described in Table 3. It showed that the prototype obtained a valid value. Several revisions that have been made to improve the prototype of reducing the characteristics that would be used for designing and clarifying the syntax of learning to be used during the summative evaluation. After the summative evaluation was done, the students' achievement score was written in Table 4. The student achievement shows that the prototype has the highest score at the excellent level of 38.34 ± 9.77.

Table 3. Scores of formative evaluation results of research-based learning models on biology learning

No	Aspect	Indicator	Result evaluation			
			Poor (χ ± STDEV)	Fair (χ ± STDEV)	Good (χ ± STDEV)	Very Good (χ ± STDEV)
1	Construction	theory of learning	0,00 ± 0,00	0,00 ± 0,00	3,00 ± 4,24	0,00 ± 0,00
		learning model	0,00 ± 0,00	0,00 ± 0,00	3,00 ± 8,49	0,00 ± 0,00
		design research	0,00 ± 0,00	0,00 ± 0,00	0,00 ± 0,00	4,00 ± 8,49
2	Characteristic	learning based research	0,00 ± 0,00	0,00 ± 0,00	3,00 ± 8,49	0,00 ± 0,00
		modern instructional	0,00 ± 0,00	0,24 ± 2,66	1,94 ± 21,96	0,88 ± 9,98
		curriculum based competency and Indonesian national qualification framework	0,00 ± 0,00	0,00 ± 0,00	1,00 ± 5,66	2,67 ± 15,09
		adaptive instructional system	0,00 ± 0,00	0,4 ± 1,13	1,8 ± 5,09	0,8 ± 2,27
3	Content		0,00 ± 0,00	0,00 ± 0,00	3,00 ± 0,00	0,00 ± 0,00
4	Indonesian language		0,00 ± 0,00	0,00 ± 0,00	3,00 ± 0,00	0,00 ± 0,00

Note: χ = Means, STDEV= Standard Deviation. χ >3.20 is Very Good; 2.40< χ ≤3.20 is Good; 1.60< χ ≤2.40 is Fair; χ ≤1.60 is Poor

Table 4 Formative evaluation score based on achievement of student learning outcomes after the application of research-based learning model on biology learning

No	Students Achievement											The level of product goodness value after used
	Criteria		Cognitive			Skill			Attitude			
	Score	Quality	∑	X	*STDEV*	∑	X	*STDEV*	∑	χ	*STDEV*	
1	85 – 100	A	27	30.68	2.60	18.25	20.75	1.76	14	15.90	1.35	Very Good
2	80 – 84	A-	18	20.45	1.73	14.25	16.23	1.40	9.66	10.98	0.93	
3	75 – 79	B+	20	22.73	1.92	25.75	29.40	16.1	21.33	24.24	2.05	Good
4	70 – 74	B	9	10.23	0.86	10.5	12.01	6.01	2.66	3.03	0.25	
5	65 – 69	B-	6	6.81	0.57	14	16.14	3.59	16.33	18.56	1.57	Fair
6	60 – 64	C+	4	4.54	0.38	1.5	1.73	0.68	7	5.68	0.48	
7	55 – 59	C	3	3.40	0.28	1.5	1.71	0.93	7.33	8.33	0.70	
8	45 – 54	D	0	0	0	0	0	0	2.66	3.03	0.25	Poor
9	< 45	E	1	1.13	0.09	1.75	2.01	1.21	9	10.22	0.86	

Note: n participant =88; ∑ = number of students; χ = means; *STDEV* = Standard Deviation

Preliminary research and prototyping stage results showed that (1) prototype model was constructed based on 9 main competencies and 14 supporting competencies that must be mastered by the students; (2) prototype model was designed on the basis of 9 theories/concepts, (3) formative evaluation results showed that the prototype was valid with some revisions. These findings showed that prototypes of research-based learning models were supported by good empirical data. So, it can be concluded that the prototype has good value on the content and construct validity aspects (content and construct validity). The findings also exposed that there was a logical intervention so that the prototype had a state-of-the-art (scientific) knowledge.

The results of assessment stage showed that there was an instructional impact from prototype intervention which designed, and the process of applying the 5 components of the

research-based learning model ie syntax, reaction principle, social system, and support system. The impact of such instruction was the excellent score of student learning outcomes. These results showed that the expected outcomes before the intervention were performed in accordance with the results found after the intervention. These explanations described that research-based learning models on biological learning met internal relevance criteria and consistency. The internal relevance and consistency aspect of the research development was determined by the extent of expectation with the findings of research (reality) (Nieveen, 2010). The expectation of the results of the research toward the expected reality was proved by a series of evaluations such as self and expert review and application test used in small or large group test (Tessmer, 1993). So the findings of this study met important aspects in educational design research (Plomp, 2010) or/and research and development (Richey, Klein, & Nelson, 2002).

The results also showed that the development of research-based learning model on biology learning was supported by learning theory due to the application of instructional design stage that contains cognitive learning theory, behaviourist, and constructivist (Sink, 2014; Ertmer & Newby, 2013). The results of this study also showed that the development of research-based learning model on biology learning was done systematically and had a learning model component (Joyce & Weil, 1992).

The results also concluded that the research-based learning model on biology learning has been designed by considering the students' learning achievement and learning competence in accordance with The Indonesian National Qualification Framework. So the impact of nurturant effect in research-based learning model was also expected to be possessed by the students after the learning process has been completed. The expected impact of the nurturant effect was in line with some impacts on the implementation of The Indonesian National Qualification Framework, such as the increased competence of university graduates with competitively and publicly-contributed human resources (Directorate General of Higher Education, 2011).

Conclusion

Research-based learning model on biology learning has internal consistency and relevance. It has been developed based on state-of-the-art (scientific) knowledge, a number of good theories; so that the product has good content and construct validity. In conclusion, the expected product (expectation) is in accordance with the product produced (actual). However, the product of this study requires a wide-scale test of implementation to increase its resistance to revision.

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