

# Prototype Design Development of Meta-Inquiry Learning Model in Number Theory

Sinar Depi Harahap<sup>1, \*</sup>, Ahmad Fauzan<sup>2</sup>, Ellizar<sup>3</sup>, I Made Arnawa<sup>4</sup>

<sup>1,2,3,4</sup>*Doctoral Program of Education, Universitas Negeri Padang*

*\*Corresponding author. Email: : [sinardepiharahap@gmail.com](mailto:sinardepiharahap@gmail.com)*

## ABSTRACT

Prototype design is to assess the basic stage of research evaluation. The evaluation used follows Tessmer's evaluation steps. Aspects that are evaluated are in the form of RPS, SAP, development model books, student worksheets, lecturers' books and number theory teaching materials. The evaluation results were obtained from the researcher's own selection test and the expert's test. The results of the evaluation of the instrument by the researcher obtained an average value of 0.776 with the high category, and the results of the assessment of the instrument by the experts obtained 0.77 in the high category as well. The ICC value of all instruments obtained was 0.765 high category, meaning that the validator's level of confidence in the instrument was very high, in the development of the meta-inquiry pursuit model.

**Keywords:** *Prototype design, meta-inquiry learning model, evaluation, revision, number theory.*

## 1. INTRODUCTION

Mathematics education in tertiary institutions aims to prepare human resources capable of producing quality undergraduate graduates who have expertise, skills and competences in the field of mathematics, this is stated in the 2015 national higher education standard article 15 (1). The target of higher education success can be measured through abilities that include knowledge, attitudes and skills contained in the formulation of learning outcomes. According to Ledward (2011), learning outcomes are built from critical thinking skills. Critical thinking skills are very important in compiling arguments, making conclusions, making decisions, adapting and solving problems [2](Gistituati, 2018).

## 2. METHOD

This research presents part of design research and development (R & D), which is research that is oriented towards the development of a product that is described and evaluated. This study uses the [11]Plomp development model (2013: 19) consisting of three stages; 1) (preliminary research), 2) (development or prototyping phase) and 3) (assessment phase).

The Plomp development model was chosen because it has the priority of analysis in each stage of research, each syntax can be adjusted to the needs of the research,

and its development or prototyping phase is the main prototype for development to formulate and determine the answers to research problems.

In this study, we will discuss the second part of the development of the [11]Plomp, namely the prototype using the Tessmerr evaluation. The prototyping phase carried out two activities, namely designing the prototype, and evaluating the prototype as well as revising the prototype.

### 2.1 Prototype Design

Prototypes are product instruments that are still being developed in a temporary form, requiring a series of trials to get the final product that is as desired. The name of the product designed in this study consists of, first, in the form of a learning model book, [3]namely the meta-inquiry learning model, [5]whose components consist of syntax, reaction principles, social systems, support systems, instructional impacts and accompaniment impacts. Second, designing a model support system, in the form of a semester learning plan (RPS), lecture unit (SAP), number theory teaching materials, lecturer manuals, and student work training books (LKM). The three stages of designing a research instrument, in the form of a checklist sheet on the validity sheet and practicality sheet, by self-evaluations and expert evaluators, namely experts who act as

validators are mathematics experts, mathematics education experts, education experts, and language experts and number theory lecturers as practitioners, with aim to test the validity and practicality of the product.

### 2.2 Evaluation and Prototive Revision

Prototype evaluation is done to test the validity, practicality and effectiveness of the prototype. The instrument is aimed at self evaluation, and expert review to test the validity and practicality of the product.

Prototype evaluation refers to the Tessmer diagram, as [11]Plomp (2013) says that Tessmer's formative evaluation aims to test practicality, effectiveness and field testing.

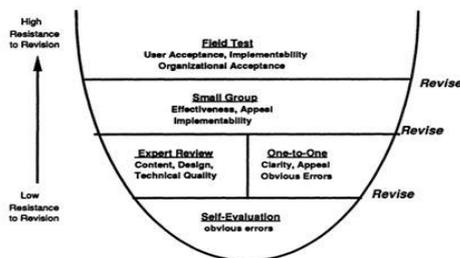


Figure 1 Stages of Formative Evaluation [1]Tessmer, (1993)

The preliminary research instrument was entrusted to 5 validators, namely, 1.Prof. Dr. Edi Syahputra., M. Pd (Faculty of Mathematics Education UNIMED), 2.Prof. Dr. Lufri., M. S (Faculty of Mathematics and Natural Sciences UNP), 3.Dr. Darmansyah, St (Faculty of Engineering UNP), 4.Dr. Abdul Rahman., M. Pd (Faculty of Arts and Languages UNP), and 5.Prof. Dr Elizar, M. Pd (Faculty of Mathematics and Natural Sciences UNP).

The second stage after the results of the self-evaluation were revised, a validity test was carried out through an expert review (expert / practitioner) along with a team of content experts, education experts, graphic experts and linguists. If the expert / practitioner recommends that the prototype is not suitable for use or needs to be revised, it will be revised again and the evaluation stage of the expert team will be repeated. If the expert / practitioner's assessment has stated the prototype is valid, the evaluation is continued at the next stage.

## 3. RESULTS AND DISCUSSION

The results of the analysis of the second stage in this development are called the prototyping phase, along with the explanation;

### 3.1 Designing a Meta-Inquiry Learning Model

Model prototypes are compiled based on the results of preliminary studies obtained from needs and context analyzes as well as studies from various literatures. The results of the [3]model book cover design show the identity of the book, there are no features or picture features that are characteristic, because the rationale of this writer is a scientific book which contains learning models. The initial cover design was modified by the researchers themselves. The letters chosen for lecturers' books are the same as for the model books, namely times new roman letters and typing is done in 1 space. [7]Model components consisting of syntax[4], reaction principles, social systems, support systems and accompanying instructional impact are adjusted to the meta-inquiry learning model.

The model [6]syntax consists of 7 stages; problem orientation, formulate problems, propose hypotheses, gather information, test hypotheses, evaluate progress, and conclude. The reaction principle of the meta-inquiry learning model is in the form of student-centered learning that facilitates students in reconstructing deeper understanding. The social system in this model maintains cooperation among students in the form of mentors, mediators, motivators, inventors and togetherness in being responsible for understanding the material, even though learning is student centered, it is still necessary to have multi-directional interaction, both interaction among students and interaction between students and lecturers. The accompanying impact that appears is in line with the learning of increasing positive attitudes in learning number theory. The direct instructional impact is the increased ability of students in understanding mathematical concepts and students' mathematical problem solving abilities. The support system in the meta-inquiry learning model is the RPS, which is described in SAP and LKM. The following is an explanation of the structure of the meta-inquiry learning model;

Table. 1. The Structure of the Meta-Inquiry Learning Model.

<b>Meta- Inquiry Learning Model</b>	<b>Syntax</b>
	1. Problem orientation 2. Formulate the problem 3. Propose a hypothesis 4. Gather information 5. Testing the hypothesis 6. Evaluating progress 7. Conclude
	<b>Principle of Reaction</b>
	1. Student centered 2. Deep thinking
	<b>Social System</b>
	1. Cooperation 2. Multi-directional interaction
	<b>Accompaniment Impact</b>
	1. Increase a positive attitude in learning

number theory
<b>Instructional Impact</b> 1. Improve students' ability to understand mathematical concepts 2. Improve students' math problem solving skills
<b>Support System</b> 1. RPS 2. SAP 3. Lecturer books 4. LKM Number Theory 5. Number Theory Teaching Materials. 6. Evaluation tool

Based on the structure [8]of the meta-inquiry learning model that has been developed, a [9]syntax description of the core activities is prepared as well as the activities of lecturers and students in learning as follows:

**Table 2.** Description of the Meta-inquiry Learning Model Syntax Activities.

Activity Stages
<b>Initial activity</b> 1. Problem Orientation a. Imagine and understand the problem b. Write down a picture of the problem according to the ideas in mind
<b>Core activities</b> 2. Formulating Problems b. Me mahami and write the problem in accordance with the mind c. Straighten or simplify the form of a problem that you know and what you don't know i
3. Submit Hypotheses a. Me check and readjust the problem with the material. b. Write down temporary answers to the problems created in formulating the problem in a logical manner. c. Re-checking the suitability of the problem with the alleged answers written .
4. Gathering Information a. Gather information material. b. write, compile and classify data or information. c. Review the material information collected.
5. Hypothesis Testing a. Analyze the questions in step two by experimenting with adjusting the answers in step three. b. Write down the problems encountered c. If there are problems, ask the group's opinion
6. Evaluating Progress a. Check, understand, adjust the results of the analysis that has been written. b. Report the results of the analysis c. Listening and concluding the analysis. d. Re-check the conclusions.
<b>Closing Activities</b> 7. Conclude a. Write a conclusion b. Describe the process of thinking and evaluation, according to the conclusions.



**Figure 2.** Meta-inquiry learning model

### 3.2 Self Evaluation Results

Based on the results of the self-evaluation in the analysis, the following picture is obtained;

**Table 3.** Self Evaluation Analysis Results

Additional Statements	Revision
1. Still need to compose an effective sentence	Make improvements by checking the statements of each instrument, adjusting what you want to measure and correcting sentences that are not yet effective
2. Replace the word with the appropriate word	
3. Still need to create a total value column	
4. Sentences need improvement	
5. Still need to adjust the measured sentence	
6. Need accuracy in using signs	
7. It needs clarity of meaning being measured	
8. Need to fix clear symbol typing	

Based on the results of the self-evaluation analysis by the researcher, it was obtained with a good category average score with a little revision after checking and needing improvement with notes that have been made. Then the [10]product validity was measured. The results of self-evaluation of 10 instruments to ascertain the extent to which the use and accuracy of the instruments to be validated by the validators, obtained a value range of 0.64 - 0.91 for the 10 instruments, with categories ranging from high to very high. In general, based on the results of the self-evaluation, it is included in the

prototype. In this self-evaluation stage, there are still corrective notes made by the researcher. Self-evaluation for lecturers' books includes indicators of instructions, objectives, syntax, materials, worksheets, assessment techniques, language, and graphics.

**3.3 Expert Review Evaluation Results**

As for suggestions and revision efforts made from the model book validity instrument[13], for brevity it is presented as follows;

**Table 4.** The Learning Model Validity Instrument Grid

	<b>Suggestion</b>	<b>Revision Efforts</b>
V1	Supporting theory, come up with a clear syntax in the instrument	Set up modeled syntax in the instrument
V2	The syntax for the statement of the instrument must be precisely to whom it is addressed	Executively analyze sentences
V3	Come up with what social system appears in the model	Added social system statement in the instrument
V4	Complete the instrument with the complete components of a model	Complete the instrument according to the model components
V5	Make sure the assessment of each instrument can be read even if only by looking	It is confirmed that the assessment of each instrument is appropriate
V6	The instrument is made in easy to understand language	Fix sentences that have not been effective
V7	The relationship between the items being measured must be clear and visible	Ensure that the statement corresponds properly
V8	Check again for each instrument that has been completed in the analysis	Make sure the measurements are correct
V9	Add a Grade Box column, with the total value, and place suggestions and input	Ensure that the value box column and the calculated total value column are appropriate.

**Table 5** The Result of the Model Book Instrument Assessment *Expert Review*

<b>Item = 8</b>	<b>V1</b>	<b>V2</b>	<b>V3</b>	<b>V4</b>	<b>V5</b>	<b>V6</b>	<b>Mean</b>	<b>Category</b>
Amount	28	27	31	40	31	32	0.79	High
Mean	0.7	0.68	0.76	1	0.76	0.8		
Category	High	High	High	Very High	High	High		

Based on the table above it can be concluded that the average value of the results of *expert* validation on the model book instrument with 8 statement items was 0.79 with a high category validation value and the results of the calculation of the confidence of all validators (ICC) for the

RPS instrument obtained a value of 0.715 with a high level of confidence.

The ICC value in validating the instrument validation sheet using SPSS 20 obtained the following picture

**Table 6** ICC Value Instrument Validation Based Product Validity SPSS 20

<b>No.</b>	<b>Instrument</b>	<b>Number of validators</b>	<b>Score</b>	<b>Validation Level</b>
1.	RPS (semester learning activity plan)	6	0.765	High
2.	SAP (lecture program unit)	6	0.821	Very high
3.	Teaching materials	6	0867	Very high
4.	Meta-inquiry learning model book	6	0.715	High
5.	LKM (student worksheet)	6	0.783	High
6.	Lecturer books	6	0.641	High

The ICC result value according to SPSS 20 on 6 instruments is in the range 0.641 - 0.867 with a high and very high sequence category order, so the level of

validator confidence in the product instrument, which is made of four high category instruments and two very high category instruments [12](Stariner, 2000 : 48).

#### 4. CONCLUSION

Model components consisting of grammar, concepts of reaction, social structures, support systems and accompanying instructional effects are adapted to the learning model of meta- inquiry. The 10 instruments' self-evaluation obtained a value range of 0.64 - 0.91, ranging from high to very high.

#### 5. AUTHOR CONTRIBUTION

The author's contribution to this study is the determination of the initial prototype design of the meta-inquiry learning model development

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