Development of syntax of intuition-based learning model in solving mathematics problems

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Abstract. The aim of the research was to produce syntax of Intuition Based Learning (IBL) model in solving mathematics problem for improving mathematics students’ achievement that valid, practical and effective. The subject of the research were 2 classes in grade XI students of SMAN 2 Sragen, Central Java. The type of the research was a Research and Development (R&D). Development process adopted Plomp and Borg & Gall development model, they were preliminary investigation step, design step, realization step, evaluation and revision step. Development steps were as follow: (1) Collected the information and studied of theories in Preliminary Investigation step, studied about intuition, learning model development, students condition, and topic analysis, (2) Designed syntax that could bring up intuition in solving mathematics problem and then designed research instruments. They were several phases that could bring up intuition, Preparation phase, Incubation phase, Illumination phase and Verification phase, (3) Realized syntax of Intuition Based Learning model that has been designed to be the first draft, (4) Did validation of the first draft to the validator, (5) Tested the syntax of Intuition Based Learning model in the classrooms to know the effectiveness of the syntax, (6) Conducted Focus Group Discussion (FGD) to evaluate the result of syntax model testing in the classrooms, and then did the revision on syntax IBL model. The results of the research were produced syntax of IBL model in solving mathematics problems that valid, practical and effective. The syntax of IBL model in the classroom were, (1) Opening with apperception, motivations and build students’ positive perceptions, (2) Teacher explains the material generally, (3) Group discussion about the material, (4) Teacher gives students mathematics problems, (5) Doing exercises individually to solve mathematics problems with steps that could bring up students' intuition: Preparations, Incubation, Illumination, and Verification, (6) Closure with the review of students have learned or giving homework.

1. Introduction
Mathematics learning in Indonesia usually still used conventional method, where a teacher more dominant learning in the classroom. In the other word, teachers who more active in solving mathematics problems. In this case, teachers often did not allow their students to solve mathematics problems individually by trying to bring up the ideas that students had. These ideas were usually used by students to solve mathematics problems. To bring up these ideas need to develop an "intuition" from within students.

According to Fischbein [5] an intuition is a cognition that appears subjectively as self-evident, directly acceptable, holistic, coercive and extrapolative. When students have to face a notion of advanced mathematics that turns intuitively unacceptable for them, they produce, deliberately or unconsciously, more acceptable intuitive substitutes: the intuitive models, that may be understood, represented and manipulated like other concrete realities [5]. Intuition can be used as a "Bridge of cognition" that connected students understanding to help them to relate mathematics problems with the
several alternative solutions. Thus, intuition from within students was very useful to determine what steps should be done to solve the problems. This is linear with the result of Fischbein and Grossman research that Intuitions may be thought of as being based on some structuring rules expressing both levels of maturation and levels of training. If the objective is to influence intuition favourably – and this is an important task of the learning process – one has to identify the structuring schemata and the specific ones which underlie the respective intuitions. Intuition can be an idea based on some structuring rules that expressing levels of maturation and levels of beginning [4]. Therefore, it is necessary to develop a students’ intuition in solving mathematics problems.

Wallis said that intuition can be developed by developing work process of creative thinking that consisted of four phases. They were preparation phase, incubation phase, illumination phase and verification phase. Furthermore, the phases can be explained as follows: (1) in the preparation phase, students define the problem, need, or desire and gather any related information of the solution or response need to account for, and set up criteria for verifying the solution’s acceptability. In this case, students prepare to solve the problem by thinking, seeking answers, and being able to ask others. (2) in the incubation phase, students step back from the problems to break away for a while and let our mind to work behind the scene. Like preparation, incubation can last minutes, weeks, even years. (3) in the Illumination phase, ideas arise from our mind to provide the basic of a creative response [15]. These ideas can be pieces of the whole or the whole itself, i.e. seeing the entire concept or entity all at once. Different from another phase, illumination is often very brief, involving a tremendous rush of insight within a few minutes or hours. This stage is commonly called as “Aha! Moment”, where at the moment is the ideas appear. Then that ideas we called intuition. (4) in verification, the final phase, students carries our activities to demonstrate whether or not what emerged in illumination satisfies the need and the criteria defined in the preparation phase. Through these phases, then the intuition that arises from within student can be raised. Therefore, learning model with developing creative thinking process with four phases in the classroom is needed to bring up students’ intuition.

According to Alison “The model is structured of teaching problems, which can illuminate processes teachers engage in during their daily planning, thus providing a useful lens to understand the nature of teachers’ planning routines and reasons underlying their decisions during this phase of teaching” [1]. In the other hand, Joyce and Weil said that there are five important elements which describe a learning model, including syntax, social systems, reaction principles, supporting systems, and the impact of instructional and companion impact [6]. The term ‘syntax’ according to Matthew is quoted by Van Vallin and LaPolla is from the Ancient Greek syntaxes, a verbal noun which literally means "arrangement" or "setting out together". Traditionally, it refers to the branch of grammar dealing with the ways in which words, with or without appropriate inflections, are arranged to show connections of meaning within the sentence [14]. Furthermore, the syntax is the study of the principles and processes by which sentences are constructed in particular languages. Syntactic investigation of a given language has as its goal the construction of a grammar that can be viewed as a device of some sort for producing the sentences of the language under analysis [2]. Therefore, the syntax of learning model in this research was defined as a framework or planning that describes an arrangement and processes the learning procedure systematically to achieve certain learning objectives which contain objectives, syntax, learning environment, and management system.

Implementation of appropriate learning model in the classroom will make students learn effectively. Students are able to solve mathematics problems and make students as good problem solver. One criterion of the problem is called a mathematical problem if students have never solved that problem and it cannot be solved by the routine solution. According to Polya, problem-solving is defined as an attempt to find a solution of a goal to achieve an objective [10]. The process of the solving problem requires a person to coordinate his experience, knowledge, understanding, and intuition to solve the problem. Therefore, intuition becomes an important role in solving mathematics problems.

Some relevant research results that used intuition-based learning models such as the results of the research were conducted by Usodo [13], the results of the study indicate that learning by using stages that can bring up the intuition who initiated by Wallis was able to improve students’ ability in solving mathematics problems. In addition, other research conducted by Syahputra et al. in SMP 6 Medan mentioned that the relationship between students’ intuitive thinking with students’ mathematics
achievement in SMP 6 Medan was positive and real [12]. This means that students with intuitive thinking can improve students learning achievement of mathematics in the classroom. Therefore, it was developed a syntax of Intuition Based Learning (IBL) model in solving mathematics problems to improve students achievement.

The syntax of Intuition Based Learning (IBL) model is learning steps in the classroom which contains the phases of Wallis model that can exercise students to bring up students’ intuition in solving mathematical problems. The preparation phase, incubation phase, illumination phase and verification phase.

Based on the descriptions above, then it was developed a syntax of Intuition Based Learning (IBL) model in solving mathematics problems. The purpose of the research was to produce syntax of Intuition Based Learning (IBL) model in solving mathematics problem that valid, practical and effective.

2. Methods
The type of this research was a Research and Development (R&D). Research and Development (R & D) is a research method that uses to produce a certain product, and then do test the effectiveness of the product [11]. The development process was adopted by Plomp and Borg & Gall (in Khabibah) development model, i.e. Preliminary investigation step, Design step, Realization step and Test, Evaluation and Revision step [7,9]. The process of development can be explained as follows, (1) Preliminary investigation step. In this step conducted all related information, context analysis, and conducted several related studies, (2) The design step. By examining the results of the preliminary investigation, then designed the draft of syntax Intuition Based Learning (IBL) model. The syntax of learning models was designed will include steps that exercising students to bring up students’ intuition in solving mathematics problems. In this case were used open-ended questions, including the preparation phase, incubation phase, illumination phase and verification phase. (3) Realization step. In this step, all the designs that have been designed at the previous step will be realized more clarity and detail. The results of this step were named as the first draft. (4) The testing, evaluation, and revision step. In the test validation, was did validation of the first draft to the expert validator, and then after being declared that first draft was valid, it was evaluated by tested the syntax of IBL model. The testing was conducted to determine the practicality and effectiveness of the model syntax. In this test was observed by two observers. After testing, it will be analyzed whether the syntax of IBL model had practical and effective criteria or not. If not yet, then the syntax of IBL model will be revised and re-tested. At this step, activities continued until the syntax of IBL model was valid, practical and effective, (5) Focus Group Discussions (FGD) were conducted to evaluate the result of syntax model testing in the classroom that has been conducted, and then to get some suggestions for the next testing. This FGD involved some practitioners of mathematics education and involved an expert who understood about the learning model.

In the validation and the testing of the syntax of IBL model, there were several supporting research instruments required. These instruments were also developed and adapted with the implementation of the syntax of IBL model. Some of the instruments were developed in this study included, (1) student response questionnaire, (2) observation sheets of model implementation, and (3) validation sheets.

2.1. Data Collection Methods
Data collection methods that used to collect the data in this study were, (1) check list method, this method was used to ask validator in assessing syntax of IBL model by giving a sign (Ö) on column which has been provided, (2) observation method, this method was used to collect the model implementation data by observing the learning activities in the classroom using the syntax of IBL model by two observers, (3) the questionnaire method, the questionnaire data collection method was used by distributed a response questionnaire to the students whose learning implemented syntax of IBL model, and (4) test method, this test method was used by distributed STS (Student Test Sheet) to be solved by students individually. This test was used to measure the effectiveness of syntax of IBL model syntax.
2.2. Data Analysis
The data that had collected then analyzed quantitatively and directed to answer whether the syntax of IBL model had valid, practical and effective or not. Analysis of the validity data by: did recapitulation of all results from the validator, calculated the average value of each validator, calculated the total mean of the three validators, categorized the value of the validity by the predetermined category, and then decided the value of the validity of syntax of IBL model. References that used by researchers to determine the category interval in this study were adopted from Darwis [3]. Practical data analysis was done by recapitulated all result that given by the observer about the implementation of the syntax of IBL model in the classroom, calculated the percentage of the value of each observer, calculated the total average of the two observers, determined the category of model syntax implementation based on predetermined category, and then decided the practicality of syntax of IBL model. Effectiveness data analysis was performed by recapitulated all students’ scores that obtained from Student Test Sheet (STS) and student response questionnaires, calculated the mean of all students’ scores from each STS, calculated the increasing of the first test result to another test, calculated the percentage of the number of students who giving positive responses to each category, determined the category of effectiveness, and then the last was to decide the value of the effectiveness of syntax of IBL model.

3. Results and Discussion
The development of the syntax of IBL model began with a preliminary investigation step, the researcher did some studying and collected all related information. The results of the preliminary investigation step were: (1) based on pre-survey at SMA 2 Sragen, students were gave less problem solving training, which gave students opportunity to express their ideas, (2) Reference of intuition that used in this study refers to Fischbein, (3) learning theory that supported the syntax of IBL model was social constructivism Vygotsky learning theory, (4) the topic that used for this IBL research tested was the Slice of Two-Circle.

The results of the studying from preliminary investigation step were used as a reference for designing the syntax of IBL model and research instruments. The syntax of IBL model that had designed then realized and had been produced was referred to as the first draft. The first draft of the syntax of IBL learning was as follows: (1) Introduction, (2) Grouping, (3) Group discussions, (4) Students solving mathematics problem with the step that can bring up students intuition, (5) Closing. In addition, in this step also produced the design of research instruments, they were students response questionnaires, model implementation sheet and model validation sheet and instrument validation sheet.

The first draft was validated to 3 validators, they are (1) Prof. Drs. Tri Atmojo Kusmayadi, M.Sc., Ph.D., as a pure mathematician, (2) Drs. Paidi, M.Pd., as an education and model development expert and (3) Partono, M.Pd., a high school mathematics teacher.

The result of validation about the syntax of IBL model from three validators was valid. The average assessment of each validator was 4.00, 4.08 and 3.75. Based on predetermined criteria, the result in intervals $3.5 \leq V < 4.5$ was the valid category. Therefore, the syntax of IBL model was valid because it meets all aspects of validity. The validity of this syntax of IBL model was determined by the assessment of the validator. According to Nieveen [8], models that meet the value of validity are models which based on strong theoretical rationale. The theoretical rationale that used in this study was the theory of Vygotsky's constructive learning. In the syntax of IBL model that developed had relation with constructivism theory. There was a syntax of IBL models which students were directed to build their own knowledge as there was group discussion among students in learning process.

After the syntax of IBL model was valid and usable, then did test 1 to see the practicality and effectiveness of the syntax of IBL model. Test 1 was conducted in class XI IPA 6 SMA N 2 Sragen with 32 students. Test activity 1 was observed by 2 observers to see the implementation of the syntax of IBL model in the classroom and to determine the practicality of the model. According to Nieveen [8], that a model is said to be practical if in reality shows that the model can be applied in the classroom. Therefore, the practicality of the syntax of IBL model in this study was determined by the level of the syntax of IBL model implementation in solving mathematics problem should be high. The result of the percentage of total model implementation on test 1 was 75.92%. Based on predetermined criteria, the syntax of IBL
models had been implemented. This means that the syntax of IBL model had met the criteria of practicality.

To measure the effectiveness of the model, it can be observed from the results of student tests on student response questionnaires and STS (Student Test Sheet). According to Nieven to declare effectiveness of a model that in the reality, the model has to give results in high expectations [8]. Therefore, in this study the effectiveness of the syntax of IBL model was determined by two things: first, by the students’ test results on the STS that given at the end of each meeting and the second from the positive responses that given by the students to the syntax of IBL model.

The result of average STS 1, STS 2 and STS 3 on test 1 were 34.32, 65.94 and 66.09 respectively. While for the average value of STS 1, 2 and 3 is 55.67. Although there was an increase in student test results, based on predetermined criteria, the syntax of IBL model was not effective yet. Furthermore, the effective value when seen from the results of students responses questionnaire. The average percentage of students who responded positively to positive questions was 81.8%. While the average percentage of students who gave positive responses to negative questions was 52.08%. However, the syntax of IBL model is not effective yet based on predetermined criteria. From the result of student test and the result of students responses questionnaire on test 1, can be stated that model not effective yet.

The analysis result of test 1 it was founded that syntax of IBL model not effective yet, hence did some revision on the syntax of IBL model. This revision was based on suggestions from the FGD results that had been held, also by considered some aspects that were still lacking and then considered to validator suggestions. After the syntax of IBL model was revised and then redesigned and realized to be the second draft. The second draft was then tested. Test 2 was conducted in class XI IPA 4 SMA N 2 Sragen with 32 students. The second test activity was observed by 2 observers, to see the implementation of the syntax of IBL model in the classroom. The result of the percentage of total model implementation on test 2 is 93.52%. Based on predetermined criteria, most of the syntax of IBL models had been implemented. This means that the syntax of IBL model had met the criteria of practicality.

The result of average STS 1, STS 2 and STS 3 on Test 2 were 76.76, 88.91, and 93.14 respectively. While the average value of STS 1, 2 and 3 on test 2 was 86.27. Furthermore, there is an increase in student test results, from STS 1 to STS 2 was 15.83%, STS 2 to STS 3 was 4.76% and from STS 1 to STS 3 was 21.34%. Based on predetermined criteria, the syntax of IBL model was declared effective when viewed from students test results. Furthermore, the average percentage of students who responded positively to positive questions was 96.00%, while the mean percentage of students who responded positively to negative questions was 75.56%. Because positive responses to positive and negative questions were more than 75%, then the syntax of IBL model had been effective if seen from the results of student responses.

From the results of the test and questionnaire results of student responses above, the syntax of IBL model was said to be effective in solving the mathematics problem. Related to the results of research conducted by Usodo shows that learning by using the step that can bring up the intuition who initiated by Wallis was able to improve students' ability in solving problems [13]. This means that IBL model effective to improve student's mathematics achievements in the classroom.

Based on the description above, the syntax of IBL model had met all aspects of validity, validity, and effectiveness. Therefore, had been obtained the final product of syntax of IBL models that valid, practical and effective.

4. Conclusion

The development process of the syntax of IBL model referred to development model by Plomp and modified by Borg & Gall development model. The process of developing the syntax of IBL model has been done, they were, (1) at the preliminary investigation step, conducted the study of intuition, the study of model development, reviewed the condition of the students, and topic analyzed at SMA 2 Sragen, (2) designed the syntax of the IBL model in which there were steps that can give bring up intuition. In addition, at this step also designed research instruments, (3) realized the syntax of IBL model that has been compiled into the first draft, (4) validated the first draft to the validator. And then, after valid, the first draft was tested to class XI IPA 6 SMA N 2 Sragen. Because test 1 has not been effective yet, then it was revised syntax of IBL model, (5) conducted FGD to evaluated the test, then
revised based on the FGD result suggestion for next test. (6) Test 2 was implemented in class XI IPA 4 SMA N 2 Sragen, and obtained the final product of syntax of IBL model.

Model Intuition Based Learning (IBL) was a learning model that had met the valid, practical and effective criteria in solving mathematical problems to increase students’ achievement, especially on the topic of Two-Circle Slice. Here, was the final product of syntax of IBL model:

1. Opening with apperception, motivations and build students’ positive perceptions,
2. Teacher explains the material generally,
3. Group discussion about the material,
4. Teacher gives students mathematics problems,
5. Doing exercises individually to solve mathematics problems with steps that could bring up students’ intuition: Preparations, Incubation, Illumination, and Verification,
6. Closure with the review of students has learned or giving homework.

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