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Validity and Practicality of Integrated Guided Inquiry (IGI) Learning Model for Senior High School Students

Andromeda[1*], Lufri[2], Festiyet[3] and Ellizar[1]

[1]Chemistry Department, Faculty of Mathematics and Science, Universitas Negeri Padang, Indonesia
[2] Biology Department, Faculty of Mathematics and Science, Universitas Negeri Padang, Indonesia
[3]Physics Department, Faculty of Mathematics and Science, Universitas Negeri Padang, Indonesia

*E-mail: andromedasaidir@yahoo.com

Abstract. IGI learning model has been produced valid, and practical. The model contains rational, supporting theories, model characteristics, model instruction manuals and learning tools of the IGI model. The 4-D design instructional model was chosen in this study. The Model has been validated by experts and practicable test conducted by teachers and a number of students at SMAN 10 Padang. Instruments to test validity and practicality are questionnaires, whereas to see the implementation of IGI model by teacher and student response using observation sheet and questionnaire. Data of validity and practicality were analyzed with kappa moment. To observe the implementation of learning model IGI done with percentage technique. The result of data analysis showed that Kappa moment for model validity is 0,81 with very high category of validity. The Kappa moment value for the model's practicality is 0.93 with a very high practicality category. The result of observation data analysis of the implementation of IGI learning model in SMAN 10 Padang shows that 96.8% learning model component can be done by the teacher. From the analysis of questionnaire data of student response to the implementation of learning with IGI model showed 94.7% of students stated the learning atmosphere of IGI model is fun, 89% of students said learning becomes easier and 91,3% students expressed motivated to learn using IGI model. The results of this study indicate that IGI learning model developed valid and practical use in chemistry learning in senior high school.

1. Introduction

Educational quality problems are an inexhaustible problem to talk about. In Indonesia the quality of education is still felt not so satisfactory. The 2012 PISA and PISA 2015[1] reports show that Indonesian students' science learning outcomes are still low compared to the OECD average. The survey by TIMSS also shows that the average score of Indonesian students' achievement for IPA belongs to the low benchmark category. Students who are in the category of Low International Benchmark mean only able to recognize a number of basic facts but have not been able to communicate and link various topics of science, interpret information in diagrams, charts and charts to solve problems, and have not been able to understand the basics of scientific inquiry[2,3].

Chemistry is part of the science that studies the matter and its changes [4]. As a science, science is formed from the interrelation between the attitude and process of science, the investigation of natural phenomena, and scientific products. In chemistry there are two things that can't be separated, namely chemistry as a product (chemical knowledge in the form of facts, concepts, theories and principles) and chemistry as a process (scientific work). Thus the learning of chemistry will not be separated from laboratory activities. Inquiry-oriented laboratories have the potential to enhance students' sense of learning, conceptual understanding, higher order thinking skills, and understanding of the nature of science [5].

Based on the observation result, and the result of the questionnaire given to 50 chemistry teachers and 94 high school students in West Sumatera, the following conclusions are obtained:(1) experimental activities in schools have not been implemented optimally (the number of experiments conducted in accordance with the less syllabus of 55%), (2) experimental activities are generally conducted at the end of the theory lesson (not integrated), (3) 75% of students stated that the worksheets used for the experimental activities were less interesting because they contained guidelines such as recipe books not yet discovery-based.

The experimental activities undertaken at the end of the theory study aims to confirm the concept.The experimental activities should aim to enable students to actively explore, collect data, analyze data, and find concepts, and to solve problems. This will make students' learning motivations, learning outcomes and skills demanded by the 2013 curriculum will be achieved. The demands of the 2013 curriculum are the development of scientific thinking skills, the development of a "sense of inquiry" and the creative thinking ability of students [6].

Experimental activities are instrumental in determining the level of achievement of student learning outcomes. Several results of research relationship between laboratory activities with science learning, it was revealed that students more easily understand the concepts learned in the class through experimental activities [7]. Through experimental activities the concepts learned become more meaningful so that they are easier to remember. In addition, experimental activities can also increase students' interest and motivation in learning science. Laboratory experience (experiments) strongly supports the attainment of science education goals [8][9]. Educational experts and researchers also agree that laboratory experience is one of the main factors affecting students' attitudes in studying science [10]. Other studies have shown that learning that integrates experimental activities in theory learning can improve student learning outcomes [11].

One of the scientific learning models that can facilitate students to be actively involved in the discovery of concepts through experimental activities is the inquiry learning model. The National Science Education Standards (1996) argue that inquiry is central to the attainment of science literacy. According to Bell (2005) there are 4 levels of inquiry learning in the laboratory namely, confirmation inquiry, structured inquiry, guided inquiry, and open inquiry [12]. Of the four levels of inquiry, Guided Inquiry is one of student-centered learning. The Guided Inquiry model requires students to conduct a series of investigations, explorations, searches, experiments, searches, and research not just answering questions or getting the right answer [13]. Guided Inquiry learning is a student-centered strategy, students work in small groups with individual roles to ensure that all students are fully engaged in the learning process [14,15].

Based on the above explanation then developed a model of learning that can help teachers to solve problems in the learning process. The model developed is an integrated guided inquiry (IGI) learning model, which is a learning model that integrates experimental activities in chemistry learning in high school. The guidelines for the implementation of the developed IGI learning model are outlined in the IGI learning model book.

The learning phase of IGI was designed by modifying the guided inquiry learning phase by several authors [16,17,18]. Modification is done in the exploration stage, which is to integrate the experimental activities to find the model in the form of experimental data that will be analyzed in the stage of concept formation. At the stage of concept formation students are guided to relate facts of experimental results (macroscopic) with submicroscopic illustrations (interconnections) guided by

critical thinking questions to find concepts.

Integrating experimental activities in learning aims to enable students to actively study, investigate, collect data, analyze data, and find concepts, and be able to solve problems under the guidance of teachers (guided inquiry). In addition, this integrated experimental activity will further save the learning time so there is no need to add special time to confirm the concept through experimental activities

The purpose of the research is the result of the product in the form of a book of IGI learning model that is valid, and practical. IGI developed learning model can be used by teachers in membelajarkan learners so as to improve learning outcomes and science process skills learners high school level.

2. Research Methodology

Research type is Research and Development (R & D). The development model used is the 4D model of Thiagarajan and Semmel (1974) [19]. Model development steps can be seen in **Table 1.**

Table 1. Steps for Developing the IGI Learning Model

No	Development Stage	Activities	Description of Activities conducted on the Research
1	D e f i ne	Front-end analysis	Initial investigation of the need to develop IGI learning model,
		Learner analysis	Analyze the characteristics of learners
		Task analysis	Analyze the abilities that students must master by determining the contents in the learning units that fit the curriculum
		Concept analysis	Analyze theories and concepts for the IGI learning model, through studies of reference books, national and international journals.
		Specifying instructional objectives	Formulate learning objectives of chemicals according to high school chemical syllabus
2.	Design	Design prototype	Designing prototype of IGI learning model.
		The product's objectives	Determining the type of product , IGI learning model
		The product's target audience ,	Define the audience
		A description of the product's components and how they will be used	Determining the components of the IGI learning model product consisting of (1) syntax, (2) social systems, (3) Reaction principles, (4) Support systems, (5) Instructional impacts and impacts of accompanist.
3.	Develop	Formative evaluation	Conduct validity test (expert review, focus groups, and field test) against prototype.
		Revision	Revise the prototype based on formative evaluation results.
		Summative evaluation	Conduct practicality test and effectiveness against prototype
4	Disseminate	Spreading	Spread the product through meetings of professional associations and through scientific journals.

Source: Modified by S.Thiagarajan, Dorothy S.Semmel, and Melvyn I.Semmel (1974).

Research data in the form of, qualitative data obtained through observation and interview with chemistry teacher and high school student. Quantitative data was obtained through data collection instrument in the form of validation sheet, questionnaire of practice, learning observation sheet and student response questionnaire. The validation sheet serves to assess the initial design of the prototype Assessment of validation in terms of component content, constructs, language and kegrafikaan. Questionnaire of practicality to assess the product in terms of ease of understanding the concept and principles of the model, the use of models, benefits, and the display of model books. The trial of IGI model implementation in SMAN 10 Padang aims to see the implementation of IGI model in learning. Implementation data of IGI model by teacher is obtained through observation sheet done by observer, and student response data from questionnaire.

The validity and practicality of the data from the questionnaire of validity and practicality were analyzed using the kappa cohen formula [20]. Interpretation of data can be seen in **Table 2.**

Table 2 Category Decisions based on Kappa Moment (k)

Interval	Category
0.81 - 1.00	Very high
0.61 - 0.80	High
0.41 - 0.60	Medium
0.21 - 0.40	Low
0.01 - 0.20	Very low
<0.00	Invalid

The model implementation data and student responses were analyzed by percentage technique [21].

3. Result and Discussion

In accordance with research objectives and procedures, IGI instruction book has been produced. The results obtained are as follows.

3.1 Define stage

Based on observations and interviews and questionnaires, with some chemistry teachers and high school students in West Sumatera it can be concluded that the experimental activities in the school have not been implemented optimally, because the teachers feel they do not have enough time to carry out the experimental activities, more learning is completed in class only. Experimental activities are generally carried out at the end of learning (not integrated) aimed at confirming the concept.

Through experimental activities students should be able to relate facts from experimental results to existing theories and be able to find their own concepts. So the concepts obtained will be longer in their memory. Learning by discovery will produce meaningful learning [22]. Learning activities will work well and be creative if students can find themselves a certain rule or conclusion [23].

Learner analysis results from 94 high school students in West Sumatra are known that students academic ability in general is heterogeneous. Student learning motivation to study Chemistry also varies. In general, students feel difficulty (70.2%) and less motivated in learning chemistry because in chemistry lesson rarely conducted experimental activities. Experiments carried out only to confirm the concept. Most of the students (97.78%) expressed their excitement and eager to conduct experimental activities in the laboratory.

Students who sit in the SMA/MA level has a range of age 15-18 years. According to Piaget (1920) cognitive development of adolescents aged 12 years and above is at the stage of formal operation stage, the last stage of the stages of cognitive development. At this stage adolescents have the ability to think abstractly, reason logically and draw conclusions from available information [24]. Learning model that is developed that integrates experiment in learning mean will start by observing fact (observing something concrete) to further comprehend something abstract, inductive learning

(Hilda Taba). In the inductive approach the discussion begins with facts or data, the theoretical concepts that have been tested are repeatedly compiled upwards into a generalization then to a particular thing [25]. Someone will more easily understand something if it starts from something that exist in the environment or something concrete.

At the stage of formal operational development students have also been able to deduce something through available information. The IGI learning model helps students find concepts through information provided in instructional materials of the IGI learning model. Such information can be images, tables, graphics and others that can be obtained through experimental activities that are integrated in learning. Guided inquiry is the level of inquiry that is relevant to the characteristics of high school students because in certain processes the student still needs to get help and guidance of the teacher in doing the inquiring process [13].

The varied learning styles of students are also considered in developing this model. In general, high school students have visual, auditorial and kinesthetic learning styles. Students who have visual learning styles learn through what they see, students with learning kinesthetic learning styles through movement and touch (experimenting), while students who have auditorial learning styles learn through what they hear [26].

The task analysis aims to identify and analyze the capabilities that the student must master through the determination of the content in the learning unit in accordance with the curriculum. This analysis is done by analyzing the Basic Competence of practicing chemicals. Then the formulation of indicators. Based on learning indicators, it is designed learning steps that integrate experimental activities in guided inquiry based learning, called Integrated Guided Inquiry (IGI) learning model.

The concept analysis in this research is done by identifying and systematically arranging the main concepts of the relevant chemical material. Analysis of learning objectives is the stage of changing the results of task analysis and concept analysis into the learning objectives. This analysis is used as the basis for constructing instructional materials of IGI learning model.

From the results of front-end analysis, student analysis, task analysis, concept analysis and the formulation of learning objectives at the design stage, it can be concluded that, IGI learning model is suitable for learning chemistry. The IGI model is based on the guided inquiry learning stage by integrating the experimental activities at the exploration and concept formation stage.

Many studies show Guided inquiry. can make students more easily understand and understand the concept of the lesson, encourage students to perform well and reduce the gap between students, and can improve conceptual understanding and problem-solving skills [27] [28] [29] [30].

3.2 Design Phase

The design stage includes: (1) the product's objectives, (2) the product's target audience, and (3) a description of the product's components and how they will be used [31]. The purpose of the product in this study is the IGI learning model and the target audience is high school chemistry teachers. The resulting product is a book of IGI learning model. The components of the IGI learning model refer to the model components put forward by Joice, Weil, and Showers (1992), consisting of syntax, reaction principles, social systems, support systems, instructional impacts and escort [32]. Characteristics of each component model can be seen in **Figure1.**
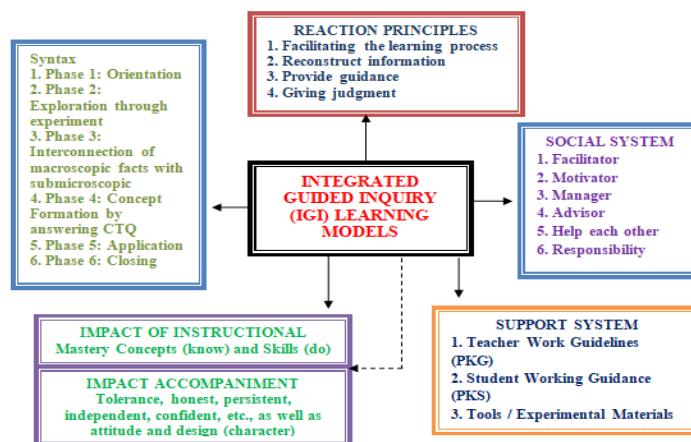
Figure 1. Component of IGI Learning Model

a. *The syntax* in the IGI learning model is a sequence of learning activities by integrating experimental activities in guided inquiry based learning. Guided inquiry learning used was adopted from the learning cycle proposed by Lawson and Abraham (1979), Hanson (2005) and Permendiknas No.59 of 2014, laboratory activities adopted from The College Board (2013) [33]. The syntax of the IGI learning model is shown in **Table 3**.

Table 3 Syntax of IGI Learning Model and Its Descriptions

Phase	Syntax	Description
Phase 1	Orientation	Orientation is the stage of connecting new knowledge with existing knowledge (old knowledge), at this stage is given in the form of information and questions
Phase 2	Exploration through experiment	This stage begins by answering the initial question (*pre-lab*), and formulating the hypothesis accompanied by preparing the experimental equipment. At this stage students explore and construct several variables in the form of data, tables, graphs, etc. obtained through teaching materials and experimental activities
Phase 3	Interconnection	Linking facts of experimental results (microscopically) with submicroscopic illustrations.
Phase 4	Concept formation	To find the concept of students guided by CTQ. Students will use the data that has been collected during the exploration stage to build the concept.
Phase 5	Application	The application is the stage of the students using the concept that has been obtained to do the exercises (post lab questions) and problems to improve the skills of the science process (PPP)
Phase 6	Cover	students make conclusions and understand the concepts learned and connect between one concept with another concept

b. *The social system*, namely the role of teachers and learners, as well as the types of rules required. In this IGI model, the teacher acts as a facilitator, motivator, manager, mentor, mutual help, and responsibility. The facilitator is not overly active but rather multiplies what the student can think and want and directs it.

c. *Principles of reaction*, which provides a snapshot to the teacher on how to view or respond to student activities. In the IGI model, teachers facilitate the learning process, reconstruct information, provide guidance, provide explanatory assistance, provide assessment and provide flexibility to learners so that the activities of learners can grow well

d. *Support system*, ie things that help achieve the goal with the application of the model. The

conditions required by the IGI model consist of: (1) Teacher Work Guidebook (PKG) is a guide for teachers in carrying out learning, (2) Student work manual (PKS) is a guidebook on learning steps that will be done by students.

e. *Instructional impact*, and impact of companion. Instructional impact is the result of learning that is achieved directly by directing students to the desired goal. Instructional impact of concept understanding and improvement of science process skills. Impact accompaniment is the result of other learning produced by a learning process as a result of the implementation of the learning atmosphere experienced directly by students without direction from the teacher. The impact of accompaniment of the IGI learning model is expected to change the attitude and action in the form of more thorough in doing the observation, work with friends, accept opinions, help each other, have a sense of responsibility, have a habit to be more accurate and honest. Observation of changes in student attitudes from this learning takes time intensive observations done not only in class but also outside the classroom.

One of the hallmarks of the IGI learning model is found in the step of learning. because in the learning step shows the activities of educators and learners in a balanced way. This balance of activity is called moderate activity. Excess moderate activity in the learning process will help the absorption of learning materials for learners who have the ability to lower middle. Another characteristic of this model is equipped with models presented in the form of multiple representation. To understand chemistry one must understand knowledge on three levels of representation ie level macroskopies, submicroscopies level, and level symbolic. With. Microscale alternatives (microscopic activity), micro-explanation so students can relate the macroscopic aspects acquired while experimenting with the miscroscopic aspects [34] [35].

3.3 Develop stage
This stage consists of three steps, namely test validity, revision, and trial.

3.3.1 Test validity
At the development stage, formative evaluation is performed to determine the quality of the product[36]. Formative evaluation is expert judgment, focus group disscusion, and field test. Experts who act as validators are lecturers, lecturers of educational technology and chemistry lecturers. After IGI model learning product is revised according to the validator's suggestion, then tested in SMAN 10 Padang to see the practicality and effectiveness of IGI learning model. The validation of the IGI learning model book is shown in **Table 4.** The assessment of IGI learning model book consists of 7 validation aspects, namely rational, supporting theory, syntax, social system, reaction principle, support system, instructional impact and impact of accompaniment, and implementation of learning model IGI .

Table 4 . Results Validity Learning model IGI

No.	Aspect of Validation	Average Moment of kappa (k)	Category of Validity
1	Rational and Supporting Theory	0.79	High
2	Syntax	0.86	Very high
3	Social system	0.77	High
4.	Principle o f Reaction	0.77	High
5.	Support system	0.83	Very high
6	Instructional impact and side effects	0.82	Very high
7	Implementation l produce m odel	0.81	Very high
8	Linguistics	0.83	Very high
9	Graphic	0.81	Very high
	Total number	7.29	
	Average	0.81	Very Valid

From **Table 4** it can be concluded that the IGI learning model book for all aspects of validation is in high and very high category. The results of this validity test show that IGI model book can be used as teacher's guide in applying IGI learning model.

The rationale presented in the model book supports the importance of using the IGI learning model. The IGI learning model is also supported by learning theory and relevant learning model theory. The underlying learning model theory is found by Joyce and Weil (2003) and Pateliya (2013) [37][38]. Learning theory is based on the theory of learning Cognitive Developmental from Jean Piaget (1920), theory of learning of Bruner's discovery (1973) and Ausubel's (Ausubel's) learning theory.

The syntax of learning is presented in a logical model book and has a wide range. This is because the learning syntax is given a phase that: 1) contains the types of activities that support the model component, 2) is the sequence of logical learning activities, 3) contains the types of learning activities, 4) clearly describes the role of teachers and students, 5) supports the achievement of learning objectives. The role of teachers in the model book is also evident. The teacher acts as a facilitator, motivator, manager, and mentor in the learning process. Student activity is expressed by the cooperation process in experimental activities and understand the concepts and responsibilities of students either individually or in groups.

3.3.2 *Revisions*
This revision aims to improve the part of the IGI learning model book that is deemed less precise by the validator before the product is tested. Some of the suggestions provided by validators are: (1) improvement on the cover (2) supporting theory, (3) layout and color settings. Based on this advice revised to produce a more perfect product.

3.3. 3 *Test of Practicality*
Practicality of IGI learning model book from the aspect of the content, linguistic and kegrafikaan feasibility. Practicality test is done based on the analysis of parkiticality questionnaire by user (teacher). The result of analysis per aspect of practicality done by students and teachers is seen in **Figure 2**
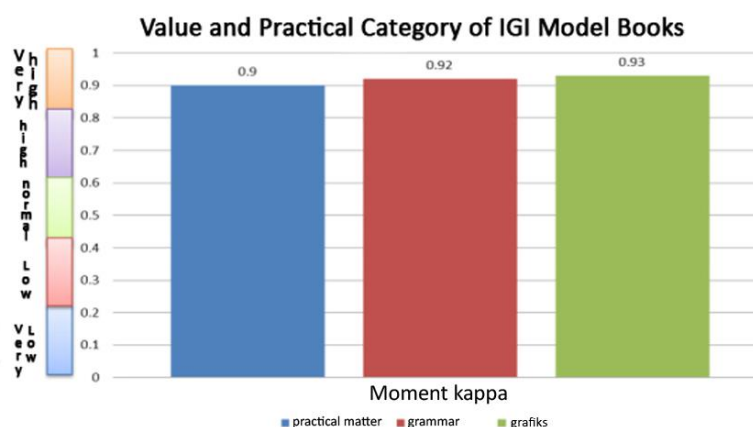

Figure 2. Kappa Moments (k) Value and Practical Category of IGI Model Books

The result of practice test of IGI learning model by user (teacher) shows that the average moment moment of kappa in every aspect is: content, language and graffiti aspect are in high practicality category. Based on these results, it can be concluded that the IGI learning model book is practically used as a guide for the implementation of IGI learning model. This model book can be used because it uses good and correct language and is easy to understand. In addition, the book display model is good because it uses a clear font, proportional font size, the color of the letters in this model book is correct, and the cover of an interesting book.

The application of the IGI learning model refers to the teacher's ability to apply the syntax, to implement the principles of reaction and social systems. To see the implementation of IGI learning model is done by using observation sheet. The experimental model of IGI learning was conducted in five meetings at SMAN 10 Padang. The result of observation of IGI learning model can be seen in **Figure 3**. Student response to IGI learning model can be done by spreading questionnaires to students after the learning takes place. The results of the student response analysis are shown in **Table 5**
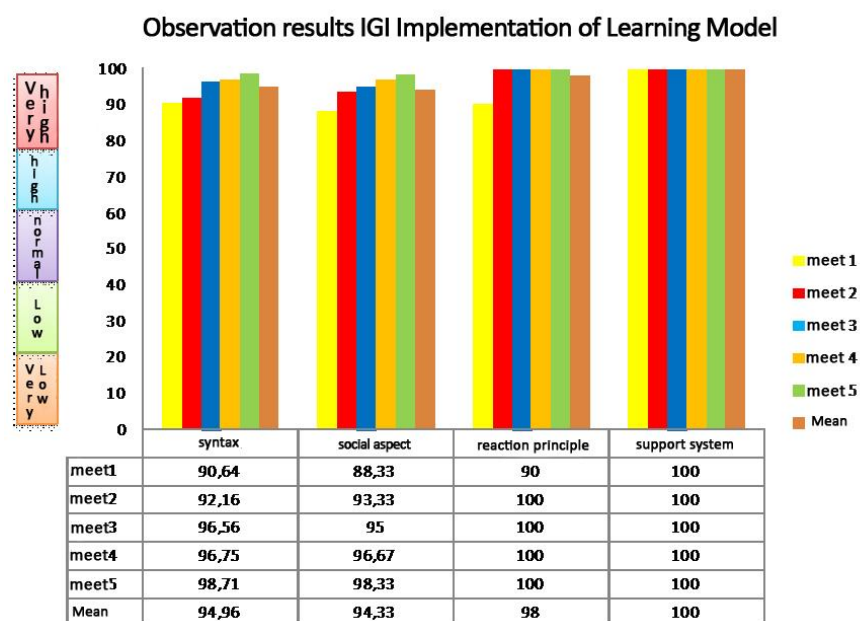

Observation results IGI Implementation of Learning Model

	syntax	social aspect	reaction principle	support system
meet1	90,64	88,33	90	100
meet2	92,16	93,33	100	100
meet3	96,56	95	100	100
meet4	96,75	96,67	100	100
meet5	98,71	98,33	100	100
Mean	94,96	94,33	98	100

Figure 3 Percentage of IGI Implementation of Learning Model and its Categorization

From **Figure 3**, the average percentage of implementation is 94, 96% for the syntax aspect, 94.33% for the social aspect, 98% for the reaction aspect principle, and 100% for the support system. The mean for all four aspects observed was 96.8%. Based on these results, it can be concluded that the IGI learning model is very practical and effective for use by teachers in learning

Table 5 Results from the Student Response implementation of the IGI Model

No.	Aspect	% Average
1.	Learning Situation Fun	94.7
2	Phase learning Motivation to learn	89
3	With the IGI model	91.3
	Average	91.7

Based on **Table 5**, a questionnaire of a student's response to the process of the IGI learning model gave the result that 94.7% of the students stated that the material presented, the learning atmosphere, the teacher's behavior, and the enjoyable learning activities. From the aspects of the material being studied, prelab questions, critical questions, postlab questions, exercises and questions posed orally by teachers while applying the IGI learning model, 89% of students stated it was not difficult / medium. From the attitude aspect of students happy with this learning model, 91,7% students have positive attitude and like to learn with IGI developed learning model

From the data obtained from the validity of data, practicality and effectiveness, it can be concluded that the IGI learning model developed is valid, practical and effective use in chemistry

learning in high school. In the dissemination phase, this learning model has been socialized at meetings with Chemistry teachers in several cities and districts in West Sumatra and also received a positive response.

4. Conclusion
Based on the results of research and data analysis has been done, it can be concluded that
1) IGI learning prototype has been successfully developed in the IGI learning model book, using 4-D development model (four-D models),
2) IGI learning model book developed valid, and practical use in learning chemistry in high school.
3) The model book produced can be used by the teacher as a guide in implementing IGI learning model in SMA

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