Validity and practicality of guided discovery learning models for chemistry learning in senior high school

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Abstract. This paper is part of a dissertation study that aims to reveal the level of validity and practicality of guided discovery learning (GDL) model developed for senior high school chemistry learning. This research and development study used 4D instructional design model. Instruments used were observation sheets and questionnaires. The product was validated by 12 experts and tested on 8 chemistry teachers and 96 students in three public senior high schools in Padang, Indonesia in 2016/2017 academic year. Observation results were analyzed by percentage technique while data of validity and practicality of GDL-PK model were analyzed with Cohen's kappa formula. Analysis showed that the average values of kappa moment (k) were 0.87 for validity test and 0.91 for practicality test belonging to very high degree category. Analysis of observation result showed that the average percentages of model implementation were 94% in SMAN X Padang, 97% in SMAN Y Padang, and 87% in SMAN Z Padang having very high degree category. Results showed that GDL-PK model was valid and practical and could be fully implemented by teachers and students in chemistry learning. Therefore, the developed GDL-PK model was feasible as teachers' and prospective teachers' considerations for senior high school chemistry learning.

1. Introduction

Discovery learning is one of learning models designed to improve critical thinking skills and develop active learning methods. The application of discovery learning models increases students' critical thinking skills as well as their learning outcomes [1-8]. However, based on data obtained with questionnaire given to 33 senior high school chemistry teachers in West Sumatra, it is found that the implementation of discovery learning model was not yet effective. Teachers have not been able to fully implement discovery learning syntax as outlined in Ministry of Education Rule No. 59 in 2014 [9]. 87.9% chemistry teachers have difficulty in implementing discovery learning model. Teachers have difficulty in applying the second stage (problem statement), the fourth stage (data processing), fifth stage (verification), and sixth stage (generalization) of the discovery learning model.

Problem statement is the stage where students are asked to identify and formulate problems raised in the stage of stimulation and write initial hypothesis of the problem raised. In fact high school students have not been able to identify and formulate the problems they meet as expected. Next, stage 4 (data processing) is the stage where students are asked to process data obtained in data collection stage. Difficulties faced by teachers include the unavailability of teaching materials that can guide students to practice their thinking skills. Furthermore, students also experience difficulty experienced by teachers in verification stage as this stage is related to problem statement stage as well. Difficulties in the fifth stage will be the next difficulties in conclusion stage (generalization).

The effectiveness of discovery learning model has not been fulfilled yet. One of the causes is that senior high school students still need teacher guidance, especially guidance to train and develop their critical thinking skills [3,10-15]. Teachers can provide optimal guidance if available learning tools such as instructional materials and learning media can improve students' activity, motivation, critical thinking skills, and learning outcomes [4,5,6,8,16,17]. However, teachers have difficulty in preparing all learning tools as intended. Therefore learning model that encourages critical thinking skills of teachers and students is required.

Based on the background above, in this study a learning model namely guided discovery learning (GDL) model for senior high school chemistry learning was developed. This model is expected to improve critical thinking skills and learning outcomes of senior high school students.

2. Methods

This Research and Development (R & D) study adopted 4-D development model consisting of define, design, develop, and disseminate stages [18]. However, this paper only reports result and analysis up to develop stage assessing validity and practicality of GDL model for chemistry learning called GDL-PK model. Procedures of define, design, and develop stages done are explained below.

At define stage, front-end analysis, learner analysis, task analysis, concept analysis and specifying instructional objectives were carried out. Front-end analysis was done by analyzing and determining basic problems experienced by teachers and students in chemistry learning. The problems were obtained with questionnaires given to 33 senior high school chemistry teachers in West Sumatra, Indonesia in 2016. Learner analysis was done by examining characteristics of senior high school students. Task analysis was carried out by identifying and analyzing capabilities that should be mastered by senior high school students and the form of assignments given. Concept analysis was done to systematically distinguish and develop the primary and supporting concepts of chemistry taught in senior high school. Specifying instructional objectives was done by analyzing the objectives, contents of GDL-PK model, and curriculum 2013 chemistry syllabus, as well as by formulating learning objectives and subject matter of senior high school chemistry.

At design stage, GDL-PK model packaged in the form of model book, teacher work manual, and student work manual was designed. The GDL-PK model was designed based on the stage proposed by Carin [12], Smitha [14] and Ministry of Education Rule No. 59 year 2014 [9] and then modified as needed. The designed guided discovery learning model for chemistry learning (GDL-PK) included syntax, social systems, principles of reaction, system support, instructional impacts and accompaniment impacts [19].

At develop stage, validity of the GDL-PK model was given to experts who consisted of chemistry lecturers and teachers. Revision of GDL-PK model was done based on expert advice until valid product based on expert judgment was obtained. Then, practicality test of GDL-PK model to practitioners who consisted of three chemistry teachers in three public senior high schools and 96 grade XI students from the three schools in Padang was also done. Practicality test was also conducted to reveal implementation of the model by teachers.

Instruments used were validity questionnaire, practicality questionnaire, and observation sheet of model implementation. Questionnaires data were analyzed with Cohen Kappa formula [20] while observation data of the implementation of GDL-PK model were analyzed descriptively [21].

3. Results and Discussions

3.1 Results

At the define stage, it was found that 66.7% teachers still taught in conventional way. On the other hand, 27.3% teachers implemented discovery learning (DL) models, 6% teachers implemented problem based learning models, 3% teachers implemented contextual teaching learning models and 18.2% teachers implemented inquiry learning model. Of the four models, model that mostly tried by teachers try was DL model. Yet, 87.9% teachers still had difficulty implementing the DL model in chemistry learning.

Teachers have not been able to fully implement the DL model syntax in accordance with Ministry of Education Rule No. 59 year 2014 that lists 6 phases of DL, namely (1) stimulation; (2) problem statement (identify problems and make hypotheses); (3) data collection; (4) data processing; (5) verification (proof); or (6) generalization. Teachers had difficulty applying the 2nd (problem statement), 4th (data processing), 5th (verification), and 6th (generalization) stages [9]. The six stages of DL model are related to students' critical thinking skills (CTS), namely the skill in expressing problems, formulating hypotheses at the stage of problem statement, processing and analyzing data at the stage data processing, providing explanatory skills and argumentation skills at verification stages and generalization.

In the design phase, design of the GDL-PK model was done as shown in Figure 1. Specifications of GDL-PK model designed can be seen from five components of the model including syntax, social system, principles of reaction, support systems, and instructional (direct) and the effect of accompaniment (indirect).

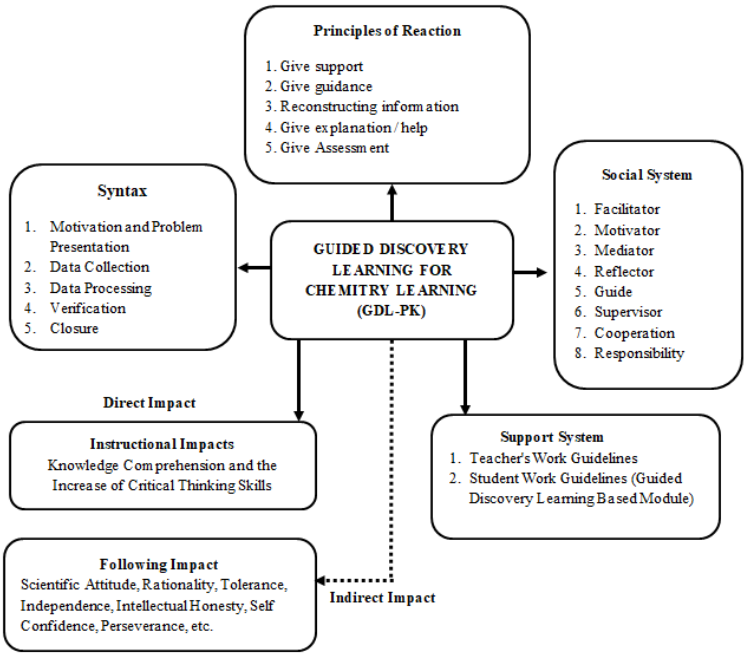

Figure 1. Components of GDL-PK Model

At the develop stage, data of GDL-PK model assessment from experts and practitioners that consisted of results of validity and practicality tests were obtained. The results of the assessment are described as follows.

3.1.1 *Validity Test Results of GDL-PK Model.* The results of the validity test of the GDL-PK model by 12 experts, namely 8 chemistry teachers and 4 lecturers can be seen in Table 1. From Table 1 it can be seen that the GDL-PK model has very high validity categories for all components assessed.

Table 1. Validity Test Results of GDL-PK Model by Expert

No	Assessment Aspect	K value	Category
1	Feasibility Content	0.88	Very High
2	Presentation	0.89	Very High
3	Language	0.87	Very High
4	Grafics	0, 86	Very High
Average		**0.88**	**Very High**

Feasibility of contents of the GDL-PK model is seen from 6 aspects, namely (1) supporting theory, (2) syntax, (3) social system, (4) principles of reaction, (5) support system, (6) direct and direct, and (7) learning approaches. The results of validity for all aspects were shown in Figure 2.

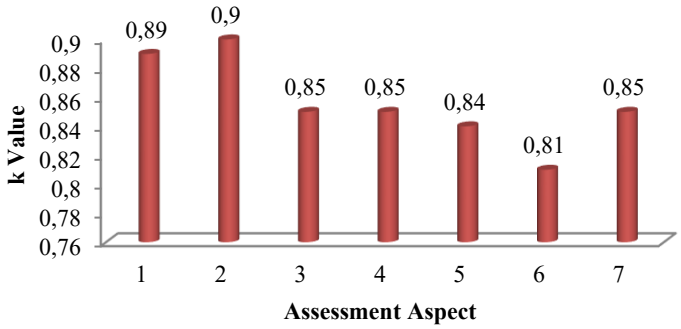

Figure 2. Practicality of the GDL-PK Model Test Results by Practitioners (Teachers and Students)

3.1.2 *Practicality Test Results for GDL-PK Model.* Practicality of the GDL-PK model test results by practitioners (teachers and students) is shown in Table 2. GDL-PK model is practical having very high practicality category for all aspects assessed.

Table 2. Practicality Test results of GDL-PK model by Practitioner

No	Assessment Aspects	K Value	Category
1	Ease of Use	0.86	Very High
2	Learning Time Efficiency	0.86	Very High
3	Benefits	0.90	Very High
Average		**0.87**	**Very High**

Practicality of the GDL-PK model is also seen from the percentage of all components of GDL-PK model implemented by teacher. The model implementation was carried out by three teachers in three schools with different levels in Padang, namely high, medium and low level schools. This model was applied in all three schools for the same subject matter, each of which had a number of meetings. Based on the observation data obtained, the implementation of the model is summarized in Table 3.

Table 3. Implementation GDL-PK model in three in Public Senior High School in Padang

No.	Aspect	Average Percentage Implementation GDL-PK model in Public Senior High School in Padang			average	**Category**
		X	Y	Z		

1	Introduction	97%	100%	96%	98%	All Implemented
2	Syntax	95%	94%	87%	92%	All Implemented
3	Social systems	93%	98%	84%	92%	All Implemented
4	Principles of reaction	90%	97%	86%	91 %	All Implemented
Average overall aspects		94%	97%	88%	93%	All Implemented

3.2 Discussions

Based on Figures 1 and 2 it can be seen that *GDL*-PK model includes 5 components of learning model as proposed by Joyce & Weil [22]. Social systems, principles of reaction, and support systems that were developed support the implementation of learning syntax [23].

From Table 1, we can see that the results of validity of GDL-PK model by experts has a kappa moment average, k = 0.88 (very high category). This means that the developed GDL-PK model is valid from the feasibility of content, presentation, language, and graphic. From the aspect of content feasibility, the GDL-PK model has an average kappa moment (k) of 0.88 (very high category), meaning that the model GDL-PK was prepared with adequate supporting theory, developed based on state-of-the art knowledge, and built by several components of the learning model [24].

In terms of presentation, GDL-PK model has an average kappa moment (k) of 0.89 (very high category), meaning that one component of the model is consistently related with other components, such as between syntax, social system, reaction principle, support system, direct impact and indirect impact. Support systems (teacher work guidelines and student work guidelines books) were also interrelated and mutually support the implementation of the model. In addition, the presentation of the model included clarity of objectives to be achieved, order of presentation, motivation, attractiveness, interaction (giving stimulus and response), and completeness of information [25].

From linguistic aspect, the book of GDL-PK model has moment kappa values, k = 0.88 while that for teacher's work guidelines book is 0.84 and student work guidelines is 0.89 having very high validity categories. This means that the language used in the model book, teacher work guidelines and student work guidelines was based on Indonesian Spelling rules. Based on graphic aspects, the model book, teacher work guidelines and student work guidelines are valid with kappa moment value of 0.89 for the model book (very high); 0.80 for teacher work guidelines books (high), and 0.90 for student work guidelines books (very high). These data show that the model book, teacher work guidelines and student work guidelines have used the type, font size, appearance of the cover, layout, placement of attractive illustrations and images in accordance with standards of a book, so in overall they could be understood and used in learning. This is in line with the assessment standards of National Education Standards Agency [26] stating that teaching materials must use proper fonts, layouts, illustrations, images, photographs and display accordingly to user needs. A good lay out will create a special attraction to someone's reading interest [27].

GDL-PK model developed is also very practical according to user ratings (k = 0.87), in terms of ease of use, efficiency, and benefits. From ease of use aspect, the GDL-PK model has a very high practicality category. It means that all components of the model such as learning syntax, reaction principles, and social systems were easily understood and implemented by teachers. Teacher work guidelines and student work guidelines books helped teachers organize material according to learning objectives determined. A model resulted through development is regarded practical if practitioners theoretically state that the model can be applied in the field, level of reliability of the model is in "good" or "high" category, and the product is easy to use as well [24, 28].

The practicality assessment from teacher shows that teachers could easily implement the *GDL*-PK model developed. According to teacher, learning with GDL-PK model helped them in carrying out their role as facilitator. The availability of instruments and assessment rubrics and answer keys in teacher work guidelines books made it easier for teachers to carry out learning process. Student work guidelines books helped teachers to guide students to discover new concepts or knowledge [3].

Teaching materials provided in GDL model could guide students to learn by themselves. Using modules available in student work guidelines book, students could build and practice their thinking skills. As stated by Bruner learning will be more meaningful if students are focused to understand structure of the lesson [10]. Learning process will occur if teachers let students organize learning matter by themselves.

From learning time efficiency, GDL-PK model has a very high level of practicality with an average kappa value k = 0.86. The application of GDL-PK model made learning time more effective and efficient. The GDL-PK model guided teachers to carry out chemistry learning according to the planned time allocation. Learning with GDL-PK model was even more efficient. Based on chemistry syllabus, time allocation for colloidal system is 3 × 4 hours of learning. Using GDL-PK model in learning, this material can be finished in 3 × 3 hours of learning.

From the aspect of benefits, the GDL-PK model has a very high level of practicality (k = 0.90). GDL-PK model provided high benefits for teachers and students. It could help carrying out appropriate learning process, so that learning objectives could be achieved optimally.

Practicality of GDL-PK model can also be seen from implementation of GDL-PK model in pilot schools. Based on Table 3, the percentages of GDL-PK model implementation in the three schools were very high. The percentages of implementation in Public High Schools X, Y and Z in Padang were 94%, 97% and 88% respectively. These data show that teachers have been able to implement all components of GDL-PK model, including syntax, reaction principles, and social systems. The developed GDL-PK model has fulfilled the consistency of its expectation and its actual. Nieveen explains that a product is said to be practical, if the product is designed to be consistent and logical between its expectations and actual. Expectation is interpreted as whether the products that can be used; actual is interpreted as whether the product can be used [24].

The model of GDL-PK could be fully implemented by teacher, because this model was equipped with a support system, namely the teacher work guidelines and student work guidelines books. Completeness of information in the model is in line with the principle of guided discovery learning model. To enable effective teaching and learning in student-centered situations, appropriate learning facilities and environments must be available [15]. This is also in accordance with one of the most important principles of educational psychology, where teachers should not only present knowledge to students. Students must be motivated so that they are able to construct their own knowledge in their minds [29].

4. Conclusions and Recommendations

GDL-PK model developed has very high level of validity and practicality in senior high school chemistry learning. The *GDL*-PK model is one of the appropriate learning models considered by teachers and senior high school teacher candidates to be applied in schools, either in high, medium or low level schools.

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