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DEVELOPING BILINGUAL SCIENTIFIC-WORKSHEET FOR INDEFINITE INTEGRAL

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Abstract

The purpose of this research was to develop a valid, practice and effective a bilingual scientific-worksheet of the indefinite integrals. This research is development research with 1) Preliminary investigation phase, 2) Prototyping phase, 3) Assessment phase. Data were collected from test and questionnaire and analyzed to examine validity, practicality, and effectiveness the worksheet. The result of this research was producing bilingual scientific-worksheet of indefinite integral materials that oriented for learning achievement improvement. The validity obtained content, language, and illustration from expert judgment. The practicality was on the relation, attention, belief, and student satisfaction. The effectiveness based on the result of achievement test on indefinite integral.

Keywords: bilingual scientific-worksheet, indefinite integral, student learning achievement

Abstrak

Penelitian ini bertujuan untuk mengembangkan scientific bilingual worksheet integral tak tentu yang valid, praktis, dan efektif. Jenis penelitian ini adalah penelitian pengembangan dengan tiga fase, yaitu : 1) prelimenary investigation phase, 2) prototyping phase, 3) assessment phase. Teknik analisis data yang digunakan adalah dengan mengelompokkan data berdasarkan kualifiaksi produk, kemudian dilakukan perhitungan untuk memperoleh rata-rata yang dimasukkan dalam kategori mean ideal. Hasil penelitian ini adalah produk scientific bilingual worksheet pada materi integral tak tentu yang berorientasi menumbuhkembangkan prestasi belajar. Kevalidan diperoleh berdasarkan aspek isi, bahasa, dan penyajian, Kepraktisan scientific bilingual worksheet dalam aspek keterkaitan, perhatian, keyakinan, dan kepuasan mahassiwa. Keefektifan diperoleh dari prestasi belajar mahasiswa semester III program Studi pendidikan Matematika UPY pada materi integral tak tentu.

Kata kunci: bilingual scientific-worksheet, integral tak tentu, prestasi belajar mahasiswa

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Calculus is a compulsory subject/course in Mathematics Education Program for all universities in Indonesia. It is integrated for all mathematics material and does not change for a short period (Djohan & Budhi, 2007). Only methods and techniques in both of part which used have to be interesting to the students enjoy calculus and are active in finding concepts (Dewi, 2016). Calculus is a branch of mathematics, with material composed of limits, derivatives, integration, and infinite series. It is used in various disciplines to solve problems in almost sector of human life (Oktaviyanthi & Supriani, 2015).

The learning process of Calculus II in Mathematics Education Study Program, Universitas PGRI Yogyakarta (UPY) had used some improvement and breakthrough in learning model, handout, worksheet, and instructional media. Most of the learning kits used in calculus learning are in Bahasa. It has not been supported to achieve one of the learning outcomes in UPY Mathematics Education is English ability in learning activities of mathematics. In line with the results of studies conducted by Word Bank that higher education should provide a combination of various skills to students so that

graduates are ready to enter the job market. The primary qualifications skills have been required employers among the graduate, that are positive work habits, communication, technical, writing, English, problem solving, reading, computer, and teamwork (Marmolejo, 2016).

To producing of graduates in a qualified Millenial generation; which changes and improvements can be made on aspects of teaching and learning in Higher Education could be changing by requires teaching in higher education. Referring to Schereer & Steinbring (2006) state that "…an important condition for improving mathematical interaction within teaching consists of moving the dominating focus of communication on teaching from teacher to the learning students." A well-prepared in teaching can be used as a reference to achieve learning objectives "…a lesson plan is simply a sequential guide to how you will accomplish your instructional objectives or goals" (Partin, 2009). Dewi and Lestari (2015) said that learning tool is one of the factors that influence the learning process, one of the learning tools worksheet.

A worksheet is not less important with learning plan in teaching aids (Untayana & Harta, 2016). That was also conveyed by Wider that "…your plan for a topic should include: …details of relevant resources, such as textbooks, worksheet, ICT resources web-based material, etc." (Wilder, Sue, & Pimm, 2017). The combination of learning methods with teaching aids can adapt to the learning achievement formula contained in the curriculum. Learning tools used to support the achievement of competence. Therefore, it will have an impact on improving students' skills in analyzing Integral problems (Dewi, 2016).

Some studies stated that lectures by using teaching materials and student tasks presented in the form of handouts. Worksheet and Powerpoint which has been efficiently developed in improving student competence in Calculus Vector (Dedy, Mulyana, & Sudihartinih, 2012). Through a scientific approach to facilitate teachers or curriculum developers to enhance the learning process, by five steps or stages in detail like observing, questioning, experimenting, associating, and communicating which contains instruction for students to carry out learning activities (Untayana & Harta, 2016). In the design of a lesson can include learning steps that must be prepared for the learning process (Prahmana, Zulkardi, & Hartono, 2012). The first time the scientific model was introduced into science education in America at the end of the 19th century, with an emphasis on formalistic laboratory methods leading to scientific facts (Hudson, 2006). Nowadays, school curriculum using scientific paradigm or which is known as the Curriculum of 2013 (K-13), which steps are observation, questioning, experimenting, networking (Kemdikbud, 2013). Mathematics Education program as a produced perspective teacher in the learning process needs to be adjusted to the paradigm adopted in schools that are being enforced by the government (Dedy, Mulyana, & Sudihartinih, 2012). Furthermore, several lessons in colleges are using scientific paradigm.

Learning process in the classroom, the lecturer should have one of the skills in preparing an instructional medium (Hamdunah, 2016). Thus, construction of an instructional medium on the subject of Calculus II indefinite integral material which can teach students' independence in understanding concepts and facilitate English language skills through the development of bilingual worksheets by using valid, practical, and effective scientific models. For the next is called by bilingual scientific-worksheet.

Scientific bilingual worksheet with scientific model will give the opportunity to the lecturer to change the learning to be centered on the students and can support the achievement of competence so that student achievement is expected to increase. So, the researcher will arrange a worksheet in Calculus II course Integral that can teach students' independence in understanding concepts and facilitate English skills through the development of bilingual scientific-worksheets with valid, practical, and effective.

METHOD

This research uses research and development method or Research and Development (R & D) to produce a specific product, and also test the effectiveness of the product. According to Nieveen (2013) a product is said to be good if it meets aspects of quality, among others: (1) validity, (2) practicality, and (3) effectively. The research that consists of three stages: 1) preliminary investigation phase, 2) prototyping phase, 3) assessment phases (Plomp, 2013). Schematically, the development of scientific bilingual-worksheet is in the Calculus II course of integral matter in Figure 1.

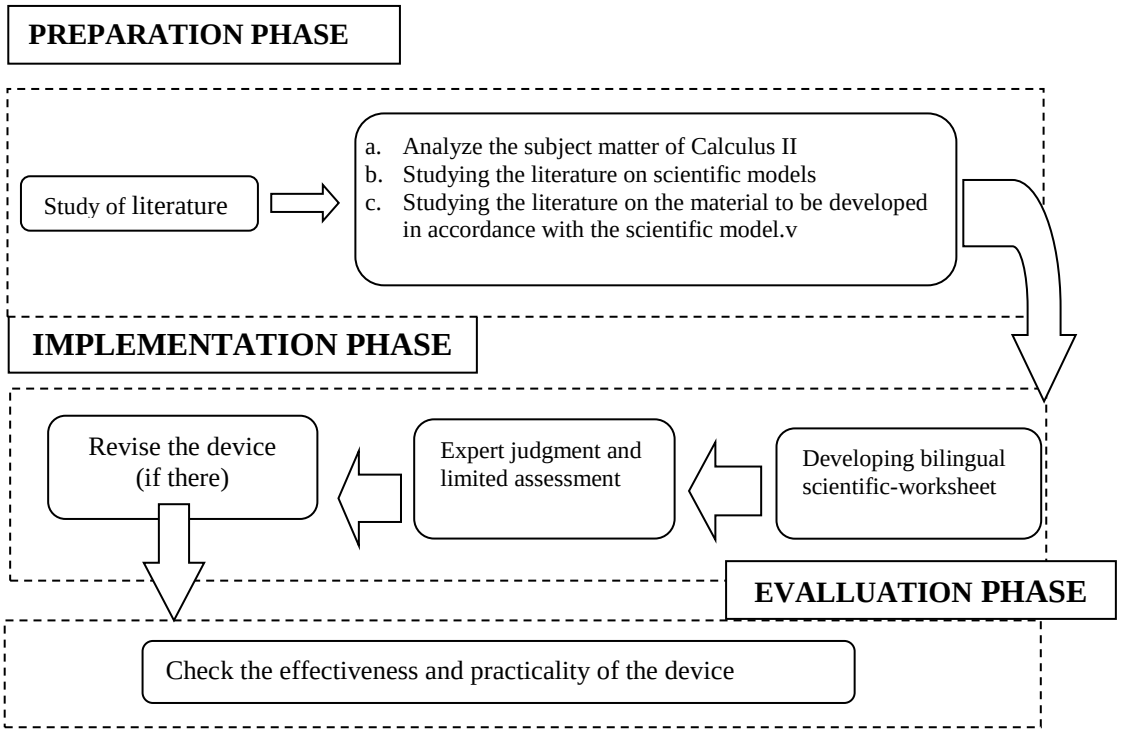


Figure 1. Schematic development of bilingual scientific-worksheet

The validity of data collected through expert judgment questionnaire is indeterminate by looking at some aspects of the content language, illustrations of the worksheet. The practicalities of data through the student response questionnaire were used to determine student responses bilingual scientific-worksheet on Calculus courses generated, also an interview with students. The effectively through cognitive tests to measure student achievement after using the learning process with scientific model. A compiled worksheet has tailored with indicators of cognitive tests.

Research instruments that have been collected are achievement test, response questionnaire, and

assessment sheet of the validity and analysis is done descriptively qualitative by referring to Table 1.

Table 1. Assessment Criteria

Range	Category
>Mi + (1,5xSDi)	Very good
Mi until Mi + (1,5xSDi)	Good
Mi - (1,5xSDi) until Mi	Enough
< Mi - (1,5xSDi)	Low

All the questionnaire results and the assessment sheet were validated and then analyzed using ideal criteria (ideal and ideal deviation standard). Having obtained the ideal and the next ideal deviation standard is qualified with the provisions as in table 1. Development of learning tools in Calculus II courses would be said to be effective if more than 50% of student learning achievement had good category.

RESULT AND DISCUSSION

The preliminary phase includes several activities, such as reviewing the Calculus II course syllabus, studying and analyzing the literature to be used in the bilingual scientific-worksheet, as well as studying the steps contained in the scientific model. Calculus II is a course in the second semester of advanced courses from Calculus I as well as a prerequisite course of Advanced Calculus. The materials discussed in the courses of Calculus II are Integral, which starts from the concept of integral to the application use analytically and geometrically. The division of material from the course of Calculus II is Definition of Integral, Integration Technique, Indefinite Integral, Definite Integral, Improper Integral, The area of a plane region, Volume of solids, and Length of a plane curve. Based on the review of the syllabus previously used, there is a change in the order of the material and the distribution of the content for each competency. Table 2 describes the changes made.

Table 2. Draft Changes in Calculus Syllabus 2

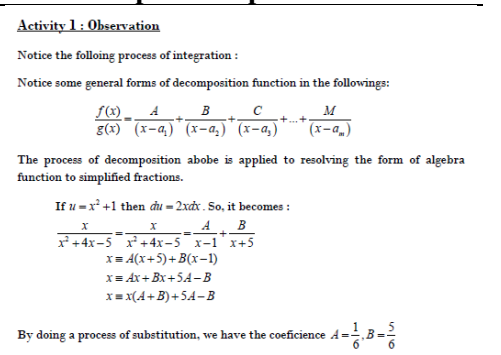
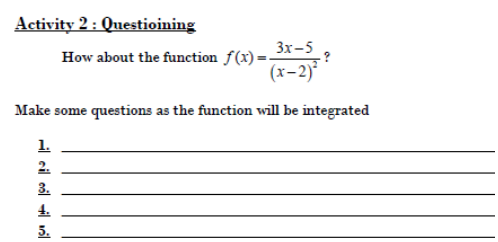
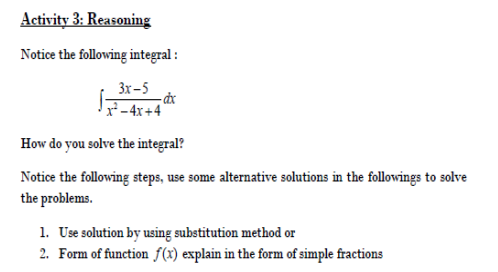
Syllabus Before Review	Syllabus After Review
Competence 1 1.1 Definition of integral, 1.2 Integration by substitution Integration by part	Competence 1 1.1 Definition of indefinite integral 1.2 Integration by substitution (Algebra and Trigonometri)
Competence 2 2.1 Integration by substitution 2.2 Integration of irrational function	Competence 2 2.1 Integration by part
Competence 3 3.1 Integration trigonometric function 3.2 Trigonometric substitutions	Competence 3 3.1 Integration of rational function by partial fraction 3.2 Integration of irrational function
Competence 4 Definite integral: 4.1 Fundamental Calculus Theorem 4.2 Characteristic definite integrals	Competence 4 4.1 Definite integral 4.2 Fundamental Calculus Theorem 4.3 Characteristic definite integrals
Competence 5 5.1 Improper Integral	Competence 5 5.1 Improper Integral

Syllabus Before Review	Syllabus After Review
5.2 The area of a plane region	5.2 The area of a plane region
5.3 Volume of solids	5.3 Volume of solids
5.4 Volume of solids of revolution: shells	5.4 Volume of solids of revolution: shells
5.5 Length of a plane curve	5.5 Length of a plane curve

Integral of trigonometric function in previously syllabus was presented on competence 3, which is specific to the integrals of the trigonometric function. It was changed to the competencies 1 and 2 included in the integration sub-subject. This change was made after looking at some of the Calculus book references, the division on integrating engineering material based on the algebraic function and the function of trigonometry. Bilingual scientific-worksheet developed on competence 1, competence 2, and competence 3.

In the next stage is the prototyping phase, which identifies the material to be used in preparing the bilingual scientific-worksheet, and also do an expert judgment assessment. Five phases of the scientific model are observing, questioning, experimenting, associating, and communicating. Descriptions of each activity on the bilingual scientific-worksheet are on Table 3.

Table 3. Description of activities on bilingual scientific-worksheet

Scientific Phase	Activity	Example of Implementation
Observing	Activities at the observing phase in the form of student activities observed the problems presented as apperception. That is in the form of problems or materials of the previous concept. The purpose of observing activities is to have the same students' initial knowledge.	
Questioning	Activities undertaken questioning phase are a continuation of the observing phase. In this phase the students are given the stimulus that is at the phase of observing in order to have the creativity to be able to explore problems or materials at the observing phase.	
Experimenting	After going through two phases of observing and questioning, the next phase is experimenting. At this phase the activity of the students is through the process of thinking about the concept of integral. Activities are arranged logically and systematically so that students get a conclusion of knowledge about integral.	

Associating	Students know the concept of materials at the experimenting phase. Furthermore, activity at the associating phase applied students the concept of resolving the integrals that have owned the previous phase.	**Activity 4: Attempt** Make a question if the funcions will be integrated 1. $\int \frac{x+5}{x^2-2x-3}dx$ 2. $\int \frac{3x-5}{(x-2)^2}dx$ 3. $\int \frac{4-2x}{(x^2+1)(x-2)^2}dx$
Communicating	The last stage of the scientific method is to associate. At this stage, students communicate the results of the discussions in the previous phase.	

After the bilingual scientific-worksheet has been drafted, the next step is reviewed and validated by language experts and experts in mathematical content. Assessment, the result of expert validation analysis is presented in Table 4.

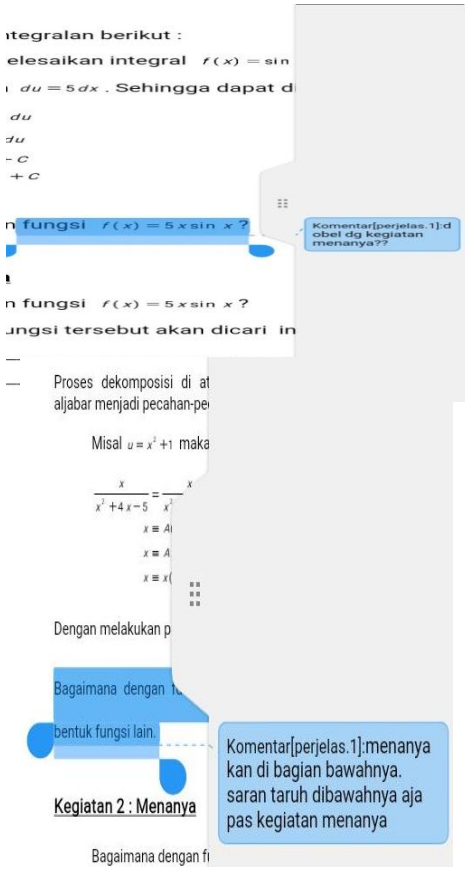
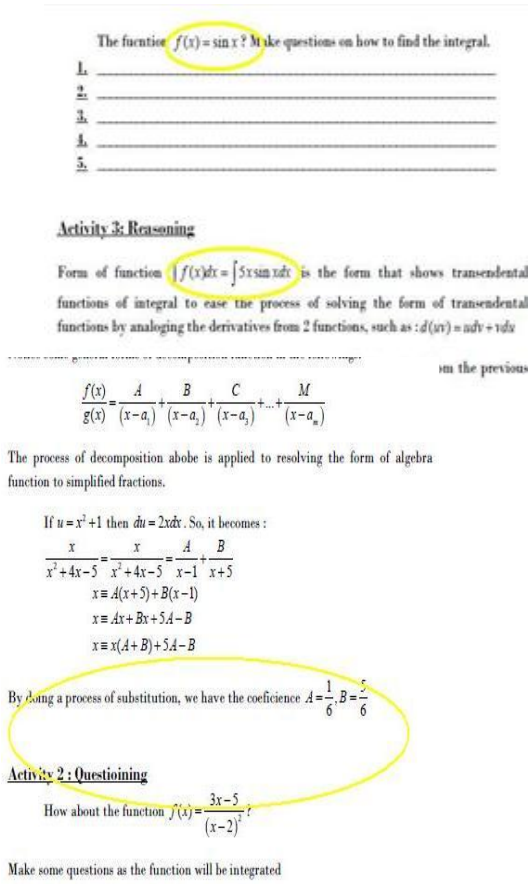
Table 4. The results of Expert Bilingual Scientific-worksheet Validation

Rated Aspect	Average Expert Rating Score	Category
Content		
Competence 1	8	Valid
Competence 2	8	Valid
Competence 3	7,67	Valid
Competence 4	7	Valid enough
Language		
Competence 1	8	Valid
Competence 2	8	Valid
Competence 3	7,25	Valid enough
Competence 4	7,75	Valid
Illustration		
Competence 1	7,67	Valid
Competence 2	8	Valid
Competence 3	8	Valid
Competence 4	8	Valid

Table 4 showed the contents of the bilingual scientific-worksheet of competence 4 with the average score valid enough, because on the experimenting activity was similar to the questioning activity. The reasoning activity on competence four should be through the process of thinking about the concept of integration. However, in the bilingual scientific-worksheet repeats the problem in previous activities so it becomes not systematic and logical to find the concept of integral that is absolute. The aspects of language on the competence of 3 were enough categories. The expert judgment suggests that competence validator 3 needs some improvement on conformity with the achievement of competence, activity at experimenting stage made to be more interesting, and easiness of the student in understanding the language used.

Based on validation sheet of expert judgment on competencies 3, it showed the revision in the observed activity. Their activity needs to add to apperception material, which is a process of decomposition to algebra function. Table 5 presents revisions to competencies 3 and 4.

Table 5. The results of revisions to competencies 3 and 4

Before Revision	**After Revision**
	

Expert judgment has validated in the content aspect and illustration component, the other lecturers who are members of the analytical expertise group, also English lecturer in the language aspect. Validation and illustration component contains about the conformity of integral calculus material delivery with a scientific approach. The trial in a limited class done to the small group includes six students.

Evaluation of student achievement test made after using the bilingual scientific-worksheet. The average score of student achievement on competence 1 to competence 4 is 57.14. Of the 70 students, 53.13% (40 students) scored above the average, while 46.87% (30 students) scored below the average with different categories. Based on ideality criteria can be seen in Table 6.

Table 6. Category of Achievement Rating

Category	Number of Students	Percentage (%)
Very good	34	53,13
Good	14	20.00
Enough	6	8.57
Low	16	22.86

Based on the criteria of effectiveness in which bilingual scientific-worksheet is said to be able to develop student achievement if the number of students with achievement score above the average class is more than 50%. The result obtains bilingual scientific-worksheet effective for students' achievement on the indefinite integral. Based on the researcher's observation of the student answer sheet, the student's mistake lies in the inability to understand the problem and determine the settlement strategy. Students' interview result showed that the students' incapacity to solve the integral-problems caused students are less practice to solve the problem with various types of questions. Through a scientific approach, three are four steps that can improve students' ability in solving the integral-problems, that is observing, experimenting, and associating. Kurniawan et all (2018) stated that students' mathematical ability had potential effects by developing a problem. In line with Wibowo (2017) that scientific approach effective can improve students' learning achievement than conventional learning on observing, experimenting, associating, and communicating. According to Untayana & Harta (2016) research on learning kits using a scientific approach, it could be effective to improve students' learning achievement.

Student response was measured by questionnaire instrument and analyzed quantitatively. The result of student response in bilingual scientific-worksheet has presented in Table 7.

Table 7. The Result of Student Response Questionnaire

Criteria	Total Score Per aspect	Percentage (%)	Category
Attention	1143	75,60	Practical
Linkages	496	76,54	Practical
Confidence	588	68,06	Practical
Satisfaction	176	81,48	Very Practical
Average	75,42		Practical

Table 7 showed students' response based on the attention, interest, belief, and satisfaction of the students after they are used bilingual scientific-worksheet. The largest distribution of data is on the scale of 3 (good) from the scale of 0 to 5. The amount of students who choose the answer on a scale of 3 is 64.69%, while the remaining as much as 18.64% on a scale of 1-2. Students' interview showed that the application of existing concepts in the bilingual scientific-worksheet on integral does not necessarily facilitate students in understanding the material and feel easy to remember the integral-

concepts of lecture materials. It is because students find their integral-concepts. Based on the results of the analysis of the data, it would conclude that the response of students to all aspects and every aspect showed a positive response (very good). One of a factor which influences the practicality of learning kits could support by phase on scientific approach (Hosnan, 2014).

According to the result of validity, practically, and effectively of bilingual student were presented that scientific model has characteristics of "doing science." This model facilitates the teacher curriculum developer to correct learning process, with analyzing process into step and stage with carefully that there is instruction for the students to doing learning activity. The learning process becomes one of the solutions to overcome the lack of skills phenomenon experienced by college graduates. The innovation of calculus learning as a branch of mathematics through bilingual scientific-worksheet is expected to facilitate students to develop learning achievement and to develop English skills. The worksheet is one of the materials of the lesson that can improve the skills of students to analyze and finish their problem independently by five phase on scientific. Bilingual-worksheet with scientific model will give the opportunity to the lecturer to change the learning to be student-centered, increasing student learning achievement.

CONCLUSION

This research has produced bilingual worksheet using the scientific approach to indefinite integral is valid, practice, and effective. Qualitative validity obtained from expert review and quantitatively obtained by using mean ideal. Based on the analysis, students' achievement whose in very good category indicated that scientific phase could improve students' achievement. Furthermore, at the experimenting activity applied the concept of resolving the integrals. In addition, students' achievement in low category was caused the incapability of English competence, especially on terms in Calculus Integral. The highlight of scientific approach activity on bilingual scientific-worksheet through experimenting activity, at this phase the activity of the students is through the process of thinking about the concept of integral. Activities are arranged logically and systematically so that students get a conclusion of knowledge about integral.

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