Development of Student Worksheet Based on The Constructivism on Subject of Organic Chemistry II Study Program of Chemistry Education of FKIP UR

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Abstract. The learning of organic chemistry in Study Program of Chemistry Education, FKIP UR has not been using an effective, innovative, and valid of student's work sheet (SWS). Lecturers try to develop of SWS based on constructivism in organic chemistry II course. The formulation of the problem in the research is: how to develop SWS based on constructivism that valid in organic chemistry II course? The type of this research was R and D (reseach and development) with the 4-D development model which include Define, Design, Develop, and Disseminate. This research was to develop phase and be continue with a definite tryout. This research was conducted in FKIP Universitas Riau. The object of this research was the SWS based on the constructivism at material aldehyde ketones, carboxylic acids, amines, and free radicals. The data analysis technique used for this research was descriptive statistic. The descriptive analysis done by calculated the percentage of validation value. The average score of valuation to five expediency aspect of SWS by validator's team, such as the didactic, construct (course and language), technical and characteristic of constructivism has expediency value continued is 94,66%, 98,44%, 96,29%, 92,20% and 95,02%. Thus, the average score totality of SWS based on the constructivism subject of organic chemistry II is 95,32% which is in valid criteria, means that the SWS developed is proper to be use. Whereas percentage response of student to SWS is 85,90% with very good criteria

Keywords: Constructivism, Development, Organic Chemistry II**,** Student's Work Sheet

1 Introduction

The learning of organic chemistry in study program Chemistry Education of FKIP UR has not been using an effective student's work sheet (SWS), has not been innovated and has never been validated by experts. The effort made by the team of course supervisor is not yet optimal, but the lecturers are developing the SWS in the organic chemistry II course. The lecturer needs to apply one of the student-centered learning models that is the learning model of constructivism that connects young people to build their

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knowledge using existing ideas and knowledge approaches, applying them to new and new knowledge gained by building on existing intellectuals [1]. To implement the constructivism model needs to be supported by the tool that is SWS based constructivism.

Constructivism is a teaching philosophy based on the premise that by reflecting on experience, we build, construct knowledge, our understanding of the world we live in [2]. Constructivism underlies the idea of the given knowledge given something of nature because of the result with man, but the work (formation) of the active man himself.

In general, learning with a constructivism approach includes four stages. The four stages [3] are the apperception stage (expressing the initial conception and arousing student learning motivation), the exploratory stage (investigating and discovering concepts through collecting, organizing, and interpreting data), the discussion stage and concept explanation (discussing and seeking solutions based on the results of observations made), the concept development and application stage (applying conceptual understanding obtained by solving a problem/question that is quite complex). The four stages of constructivism can be seen in Figure 1.

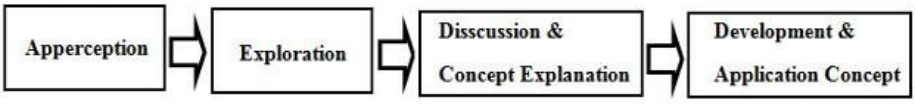

Fig. 1. Stages of Learning-Based Constructivism

In the process of constructivism learning, students must be actively involved and become the center of learning activities in the class [4]. Educators can facilitate this process by teaching in ways that make information more meaningful and relevant to students. For that educator must give opportunity to student to find and applying that can be facilitated by teaching material in form of Student Work Sheet (SWS). To be able to apply the constructivism learning model, lecturers of course will try to design the SWS based on constructivism in organic chemistry lecture II so that at the end of the lecture the student is expected able to construct the concept in the mind so that the student becomes active in the learning process.

Student Worksheet (SWS) is a teaching material that has been packaged in such a way that students are expected to learn the material independently. SWS include activities that must be undertaken by the student to maximize the understanding in the effort to establish basic capabilities in accordance with indicators of achievement of learning outcomes that must be pursued. Therefore, SWS designed based on constructivism are expected to be a means for prospective students to apply the constructivism learning model in organic chemistry II.

Development of Student Worksheet has been done by previous researchers by applying different bases such as: Research conducted [5] entitled "Development of Problem Based Learning Student Worksheet on Differential Equal Differential Equations" that the SWS developed can improve students' activeness and independence in the lecture process. Similar research conducted [6] entitled "Development of Problem-Based Student Worksheets and Projects in Data Analysis Courses" states that the use of SWS can encourage students to have meaningful knowledge, be motivated to learn and solve

problems and projects in Student Worksheets independently and more actively in lectures. A similar study [7], entitled "Development of Contextual Student Worksheets in An Inorganic Chemistry Courses" states that SWS developed for inorganic chemistry study meet the valid criteria of format, technical and content. The same research was also conducted [8] entitled "Development of Student Worksheet Based on Thinking Skills Applying Learning Model Based on Problems in Elektromagnet Field."

The lecturer team feels the need to conduct development research with reference to development research model which will be used to produce certain product and test its effectivity [9]. Certain products in this development study are SWS that should comply with requirements such as didactic, construction and technical requirements [10]. As a guidance in the development of tools one of which is validation instrument that will be used validator will be prepared in accordance with aspects according to the provisions of the implementation of validation that includes:

1. Relevance: Whatis the scope of depth, degree of difficulty and suitability of the presentation steps can develop the intellectual, emotional learners who are slow, moderate, or clever
2. Scientific: Whether the activities that are charged in the SWS are correct, accountable and emphasizes the process of finding concepts (processing information) and is an indication for students to develop themselves.
3. Flexibility: What are the SWS designed can accommodate the diversity of students as the community demands
4. Systematic: Whether the components in the SWSsupport the competency achievement, the students perform various activities such as writing, drawing, asking (comunication, participation) to friends and using tools.
5. Following the principles of effective learning is the learning experience is determined by the personal development goals of students is not determined by the learning materials.

This research step refers to the development and research using a 4-D development model consisting of studying research findings related to the product to be developed, developing the product based on the findings, testing the developed product, revising to correct the deficiencies found.The research aims to develop learning tools in the form of Student Work Sheet (SWS) for the course of Organic Chemistry II in the form of a practical and valid SWS prototype that has been validated internally and externally and ready to be tested to FKIP chemistry students

2 Methodology

This research step refers to the development and research using a 4-D development model consisting of studying research findings related to the product to be developed, developing the product based on the findings, testing the developed product, revising to correct the deficiencies found.The research aims to develop learning tools in the form of Student Work Sheet (SWS) for the course of Organic Chemistry II in the form of a practical and valid SWS prototype that has been validated internally and externally and ready to be tested to FKIP chemistry students

The preparation and development of an SWS is based on a teaching material syllabus and a constructivism-based learning model that will be applied by lecturers' team of organic chemistry II course subjects. Selection and sorting of teaching materials are deemed to be more in need of learning resources / media in the form of an SWS. The SWS's design is detailed for use in a single face-to-face semester. SWS is based on constructivism that will be designed to guide didactic, content and construction conditions. The SWS's design will be validated by the validator using the validation sheet the researcher has designed. Validator consists of 2 lecturers of Study program of Chemistry education of FKIP and 1 lecturer of FMIPA UNRI Pekanbaru. Validation results will be revised according to suggestions, feedback and improvements from validators. Category validator assessment results can be seen in Table 1

Table 1. Category of SWS Validation based of Constructivism and Material Validation

Score Rating	Category
4	SS: very match
3	S: Matches
2	KS: Less Suited
1	TS: Not match

[9]

To calculate the percentage score of each validation used equation 1.

$$\text{Percentage score} = \frac{score\,earned}{\max score} \times 100\% \quad (1)$$

To making decisions regarding the feasibility of this product development, the decision-making criteria used in Table 2.

Table 2. Product Qualification Criteria SWS Constructivism

Percentage	Description
80.00 – 100.00	Good/valid/worthy
60.00 – 79.99	Quite good/ fairly valid/ decent enough
50.00 – 59.99	Less good/less valid/less worthy
0.00 – 49.99	Noot good/replaced

[11]

In the development of time and available funds, four sets of SWS based constructivism have been created for 4 materials: SWS 1 (Aldehydon ketone), SWS 2 (Carboxylic acid), SWS 3 (Amina) and SWS 4 (Free Radicals).

3 Result and Discussion

The research that has been carried out in the study program of chemistry education, Department of PMIPA FKIP University of Riau begins in October 2017 - June 2018.

Initial stage the research team collects the materials / literature as a guideline for the drafting of SWS base on Constructivism.

3.1 Development of Student Worksheet Sheets (SWS)

The development of constructivism-based SWS on organic chemistry 2 uses the 4D development model. The SWS that have been developed have gone through the define, planning, and developing stages. The stages of developing the SWS can be seen in detail as follows.

Defining Stage (Define)

The define phase includes five main steps. First, the front-end analysis results in the creation of a limited Student Work Sheet (SWS), designed to facilitate students in understanding organic chemistry 2 material and support problem-solving abilities. Second, student analysis indicates that the users of the organic chemistry 2 SWS are 4th semester students aged 19-20 years. It reveals that some students do not fully understand the material, struggle with reasoning, and are not accustomed to high-level thinking, especially in understanding abstract concepts. Third, task analysis involves procedures for developing organic chemistry 2 materials based on Learning Outcomes (LO) as outlined in the syllabus. This analysis includes three parts: content structure analysis, procedural analysis, and information processing analysis. Content structure analysis examines the curriculum content, specifically organic chemistry 2 material, and ensures it aligns with learning outcomes. Procedural analysis outlines the stages of task completion in the SWS, which include exploration, discussion, concept explanation, development, and application of concepts. Information processing analysis results in the creation of the Semester Learning Plan (SLP). Fourth, concept analysis generates a concept map. Finally, the formulation of objectives step produces learning objectives based on the established Learning Outcomes (LO) from the task analysis.

Design Stage

The results of the design stage resulted in the initial design of the SWS and the SWS validation sheet. The initial design of the Constructivism-based SWS on organic chemistry 2 material was carried out through the following steps: formulating learning outcomes in organic chemistry 2 material and designing the SWS to include the structure of the SWS in accordance with the Guidelines for the Development of Teaching Materials (Depdiknas, 2006). This structure includes the SWS title and the titles of the activities in the SWS, which are detailed in Table 3. Additionally, the SWS validation sheet for the validator team was prepared based on the Ministry of National Education (2006) guidelines.

Development Stage

The results of the development stage are Student Work Sheet (SWS) based on constructivism on organic Chemistry 2 material.

Table 3. Title of SWS Activities 1-12

SWS Activities	Topics Covered
SWS1	1. Nomenclature, characteristics, manufacture, and addition reactions of aldehyde and ketone. 2. Addition-elimination reactions, reduction, oxidation, reactivity of alpha hydrogen to aldehydes and ketones. 3. Tautomerism, alpha halogenation, addition-1,4 in unsaturated carbonyl compounds, and applications of aldehydes and ketones.
SWS2	1. Nomenclature, physical properties, synthesis, and structure affecting the strength of carboxylic acids. 2. Carboxylic acid reactions with bases, esterification reactions, reduction of carboxylic acids, and reactions with thionyl chloride. 3. Reactivity of carboxylic acid derivatives including acid halides, anhydrides, and esters.
SWS3	1. Classification and nomenclature of amines, bonding in amines, and physical properties of amines. 2. Preparation, basicity, and salts of amines. 3. Amine substitution reactions with benzensulfonyl chloride, nitric acid, Hofmann elimination, and use of amines in synthesis.
SWS4	1. Alkanes: Free radical substitution reactions. 2. Stereochemistry of halogenation of free radicals, relative reactivity of halogens, chlorination, and bromination. 3. Other free radical reactions, initiators, inhibitors.

3.2 Validation of SWS

SWS validation was carried out by 3 validators, namely 2 Chemistry Education Lecturers and 1 FMIPA lecturer. SWS validation includes 4 aspects, namely didactic aspects, contruct which consists of aspects of presentation and aspects of language, technical aspects, and aspects of constructivism. Initial stage The research team collects the materials / literature as a guideline for the drafting of SWS base on Constructivism. Validation by the validator from colleagues has been done, assessment of didactic aspects with an average score of 3.79, construct assessment divided into 2, namely presentation and language where the average score is 3.94 and 3.85, the technical writing of the SWS generated an average score of 3.69 and the characteristic aspects of SWS based on constructivism with an average value of 3.80. The overall average of the five SWS design requirements is 3.81 with good category.

Didactic Aspects

The didactic aspect has seven assessment components which aim to assess the accuracy of the chemistry concept of the subject of the second organic chemistry in the SWS. The average score of the didactic aspect validation can be seen in Table 4 below

Table 4. Assessment of Didactic Aspects

No	Assessement component	Material				Value of Appro-proateness (%)
		I	II	III	IV	
1	SWSarein accordance with learning outcomes and indicators	4.00	4.00	4.00	4.00	100
2	SWS are in accordance with the ability of students	4.00	4.00	3.67	4.00	97.94
3	The SWS contains concepts related to students' daily lives	3.67	4.00	3.67	3.67	93.81
4	SWS are in accordance with the substance of the second organic chemistry	4.00	4.00	4.00	4.00	100
5	SWS are directing students to develop concepts	4.00	3.33	3.00	3.33	85.38
6	SWS can accompany students to discuss and communicate their opinions and work	4.00	4.00	3.67	3.67	95.88
7	SWS can accompany students to solve problems in accordance with the understanding and analysis they have learned.	3.67	3.67	3.67	3.33	89.63
	Average	3.91	3.86	3.67	3.71	94.66

Construct Aspects

The construct aspect consists of two feasibilities, namely: aspects of presentation and aspects of language in the SWS. The average score for contructural validation can be seen in Tables 5 and 6 below.

Table 5. Presentation Aspect Assessment

No	Assessement component	Material				Value of Ap-proproateness (%)
		I	II	III	IV	
1	Completeness of the SWS format (title, learning instructions, learning objectives will be achieved, Material, Steps and Questions, Conclusions.	4.00	4.00	4.00	4.00	100
2	The SWS provides sufficient space to give students the flexibility to write and describe the things students want to convey	4.00	4.00	4.00	4.00	100
3	The SWS already has a coherent system	4.00	4.00	4.00	4.00	100
4	SWS make students enthusiastic in learning	4.00	3.67	4.00	3.33	93.75
	Average	4.00	3.92	4.00	3.83	98.44

Table 6. Assessment of Language Aspects

No	Assessement component	Material				Value of Approproate-ness (%)
		I	II	III	IV	
1	SWS have easy-to-understand information	4.00	3.67	4.00	3.67	95.88

No	Assessement component	Material				Value of Approproate-ness (%)
		I	II	III	IV	
2	SWS are in accordance with standard Indonesian rules	4.00	3.67	3.67	3.67	93.81
3	The SWS uses a clear sentence structure	3.67	4.00	3.67	3.67	93.81
4	SWS use language according to the level of student ability	4.00	4.00	4.00	4.00	100.00
5	SWS are consistent in the use of terms and abbreviations	4.00	4.00	4.00	3.67	97.94
	Average	3.93	3.87	3.87	3.74	96.29

Technical Aspects

The technical aspect has four components that aim to assess the accuracy of the layout, writing, drawing / photo, and design of the SWS. The average score of technical aspects validation can be seen in Table 7 and Table 8.

Table 7. Assessment of Technical Aspects

No	Assessement component	Material				Value of Appro-proateness (%)
		I	II	III	IV	
1	SWS use good and attractive font types and sizes	4.00	4.00	4.00	3.57	97.94
2	The SWS has an interesting layout	4.00	3.33	3.67	3.67	91.69
3	The SWS has good illustrations / pictures / photos that relate to concepts	4.00	3.67	3.67	3.33	91.69
4	The SWS has an attractive display design	4.00	3.33	3.00	3.67	87.50
	Average	4.00	3.58	3.59	3.59	92.20

Table 8. Aspects of the Characteristics of SWS based Constructivism.

No	Assessement component	Material				Value of Ap-proproate-ness (%)
		I	II	III	IV	
1	The material in the SWS is to construct knowledge and not the process of receiving knowledge	4.00	4.00	3.33	3.33	91.63
2	The SWS utilizes students' initial knowledge to build knowledge about Organic Chemistry II	4.00	4.00	4.00	3.67	97.94
3	SWS can facilitate students to conduct learning activities in obtaining knowledge about the second Organic Chemistry	4.00	4.00	4.00	3.67	97.94
4	The SWS guides students to be active in conducting various learning activities that aim to build their own knowledge of the second Organic Chemistry	4.00	4.00	4.00	3.67	97.94
5	The SWS invites students to build their own new knowledge about the second Organic Chemistry by making	3.67	3.67	3.67	3.33	89.63

No	Assessement component	Material I	II	III	IV	Value of Approproateness (%)
	a connection between experience or knowledge they already have					
	Average	3.93	3.93	3.80	3.53	95.02

Based on the eligibility criteria of learning devices in Table 1, the eligibility criteria for percentage analysis 95.02% are valid. Recap the average score of the assessment of the four feasibility aspects of the SWS assessed by 3 validators can be seen in Table 9.

Table 9. Recap of Average Score of assessement of the five aspects of the SWS feasibility

No	Aspects of assessment	Average Score SWS 1	SWS 2	SWS 3	SWS 4	Overall average Score	Information
1	Didactic	97.62%	96.43%	91.67%	92.86%	94.65%	Valid
2	Presentation	100%	97.92%	100%	95.83%	98.44%	Valid
3	Language	98.33%	96.68%	96.68%	93.34%	96.26%	Valid
4	Technical writing	99.07%	89.58%	89.59%	89.59%	91.96%	Valid
5	Caracteristic of Constructivism	98.33%	98.33%	95.00%	88.33%	95.00%	Valid
	Average score overall validation					95.26%	Valid

SWS based Constructivism of the second organic chemistry that have been validated by validators are revised in accordance with the suggestions and input provided by the validator to improve the SWS, so that a valid final SWS was produced.

Validation by the validator from colleagues has been done, assessment of didactic aspects with an average score of 3.79, construct assessment divided into 2, namely presentation and language where the average score is 3.94 and 3.85, the technical writing of the SWS generated an average score of 3.69 and the characteristic aspects of SWS based on constructivism with an average value of 3.80. The overall average of the five SWS design requirements is 3.81 with good category. SWS1 [12], SWS 2 [13] SWS3 [14], SWS 4 [15].

Based on the average score recap for the assessment of the five aspects of the SWS feasibility in Table 1, it can be made a bar chart of the average scores of the 3 validators on the feasibility aspects of the SWS that is the didactic aspect, the contructing aspect consisting of the presentation aspect and the language aspects, technical aspects, and aspects of constructivism characteristics such as Figure 2.

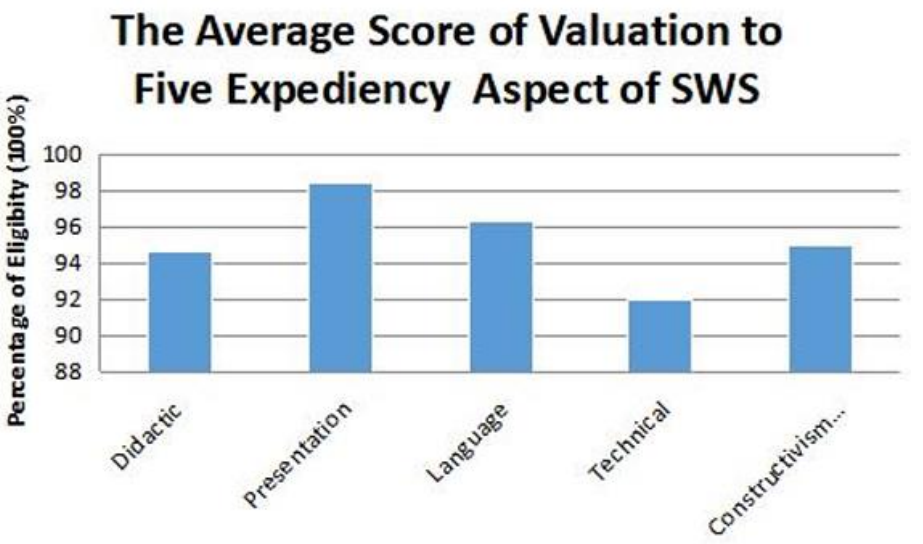

Fig. 2. Validation results of SWS that have been developed in didactic, presentation, language, technical and constructivism characteristics aspect.

Based on Figure 2 above obtained the fifth aspect of the validation of the SWS that has been developed in the category valid. However, on the technical aspects there is the lowest average SWS scores among these five aspects due to differences in manufacture and layout in each SWS, however the SWS on this technical aspect is already eligible or has been eligible to be used with valid category. While the highest value is in the presentation aspect with valid category.

The didactic aspect assessment of the SWS consists of 7 components of assessment that is the result of development is in accordance with the achievement of learning and indicators, in accordance with the ability of students, contains concepts related to the daily life of students, in accordance with the substance of organic chemistry 2, concept, can lead students to discuss and communicate their opinions and work results, and can lead students to solve problems in accordance with the understanding and analysis they have learned. This is consistent with [16] argued that activity in constructivism requires information processing, contains concepts, confidence to communicate and ask questions in groups.

Assessment of construct includes two aspects: presentation aspect and language aspect. Aspects of presentation of SWS designed by researchers consists of 4 components, namely, first, already has a complete format (title according to the material, instructional learning, learning achievement, short theory of work steps, questions, conclusions, reading sources / bibliography). Secondly, there is already a table that facilitates students and demands students to apply examples in learning activities, providing enough space to give flexibility for students to write and describe the things that students want to convey. Third, already has a coherent systematics and fourth, making

students the spirit of learning. This is supported by [17] that the way in which students solve problems depends on their ownwaysanddesires.

Language aspect consists of 5 components. SWS have easy-to-understand information, in compliance with standard Indonesian rules, using clear sentence structure, using language according to student's level of ability and consistent in the use of terms and abbreviations. Technical aspects consist of 4 components. SWS of development results illustrate that the writing of SWS already use the type and size of letters are good and interesting, has an interesting layout (layout), has a good illustration / image / photo, and associated with the concept and has an attractive design appearance.

The SWS based constructivism generated is expected to give students widespread opportunities to seek different information because in the course of the exercise ask the students to answer the questions correctly and clearly based on existing theories such as the student manual and other information that becomes the source of student learning in the form of internet, as suggested by [18] that student activity is directed to find and find their own answer from questionable thing, so it is expected to foster self confidence of the students themselves.

The constructivism learning model applied in the design of the SWS has placed the teacher not as a learning subject, but as a facilitator and motivator in learning. Activities designed within SWS can develop emotional social relationships among students because the learning process designed should be done by students in groups. Research of this SWS showed that student learning outcomes on organic chemistry II subject by constructivism-based students' worksheet was improved [19]. Based on Table 10, percentage response of student to SWS is 85,90% with very good criteria.

Table 10. Small-scale Limited Testing

No	Average Score				Overall Average Score	
	SWS 1	SWS 2	SWS 3	SWS 4	Information	
1	90.1%	88.65	83.9%	80.95%	85.90%	Very good

4 Conclusion

Based on the results and discussion it can be concluded that the SWS based on constructivism produced for the organic chemistry II course has been qualified according to the validator's assessment with the percentage of feasibility of the five aspects of 95.32% with valid eligibility categories.The result of limited trial of SWS to FKIP Chemical Education students who have taken organic chemistry II course got response result with percentage of 85,90% with very good criteria.

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