

## Development of high school biology student worksheets based on critical thinking skills on the coordination system concept

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Article Information	Abstract
<p><b>Keyword:</b> Development research; Senior high school; Student worksheets; Critical thinking skills; Coordination system concept</p> <p><b>Kata Kunci:</b> Penelitian pengembangan; Lembar kerja peserta didik; SMA; Keterampilan berpikir kritis; Konsep sistem koordinasi</p>	<p>Lack of critical thinking skills of students is one of the problems in education. One of the learning tools that need to be improved in order to improve critical thinking skills is the Student Worksheet (LKPD). This study aims to describe the validity of LKPD on the concept of a Coordination System Based on Critical Thinking Skills. This method uses a type of research, namely EDR (Educational Design Research) with reference to Tessmer's formative evaluation which consists of two stages, namely 1) Self-evaluation; and 2) Expert review. The Critical Thinking Skills used in this study refer to Facione. The subject of validation was two experts, namely lecturers. This type of research is a development research to produce a valid product. The results of this study indicate that the validity of LKPD based on expert tests has a valid category with an overall average of 3.41.</p>
<p><b>History:</b> Received : 16/10/2021 Accepted : 31/01/2022</p>	<p><b>Abstrak</b></p> <p>Kurangnya keterampilan berpikir kritis peserta didik merupakan salah satu permasalahan dalam pendidikan. Salah satu perangkat pembelajaran yang perlu diperbaiki agar meningkatkan keterampilan berpikir kritis ialah Lembar Kerja Peserta Didik (LKPD). Penelitian ini bertujuan untuk mendeskripsikan validitas LKPD pada konsep Sistem Koordinasi Berbasis Keterampilan Berpikir Kritis. Metode ini menggunakan jenis penelitian yaitu EDR (Educational Design Research) dengan mengacu pada evaluasi formatif Tessmer yang terdiri dari dua tahapan yaitu 1) evaluasi diri; dan 2) pendapat ahli. Keterampilan Berpikir Kritis yang digunakan dalam penelitian ini mengacu pada Facione. Subjek validasi adalah dua orang ahli yaitu dosen. Jenis penelitian ini merupakan penelitian pengembangan untuk menghasilkan produk yang valid. Hasil penelitian ini menunjukkan bahwa validitas LKPD berdasarkan uji pakar memiliki kategori valid dengan rata-rata keseluruhan 3,41.</p>

## **A. Introduction**

One of the prominent features in the 21st century is the increasingly interconnected world of science, so that the synergies among them become faster (BSNP, 2010) and increase the interaction of world citizens directly or indirectly, which is supported by advances in information and communication technology (Sukmana et al., 2018).

The development of the 21st century world is marked by the development and use of information and communication technology in all areas of life. In the world of work, the development of the competence of each individual. These competencies include the ability to think critically, solve problems and collaborate (Daryanto & Karim, 2017).

Education in the 21st century is digital era education, also known as the era of the industrial revolution 4.0. This century's education is required to be able to create a generation that is skilled in using technology, can survive by using life skills, namely in the form of hard skills and soft skills which include high-level thinking skills.

Sofiana et al. (2021) stated that in the 21st century education is very important as a guarantee that students have the skills to use information media, technology and can work and survive by using skills to live. Three 21st century education concepts have been adapted by the Ministry of Education and Culture of the Republic of Indonesia to develop new curricula for Elementary Schools, Junior High Schools, Senior High Schools and Vocational High Schools.

Biology is a subject that is closely related to everyday life. Biology is not only aimed at improving cognitive abilities, but also for structuring ways of thinking and especially in problem solving skills (Irnaningtyas, 2014 in Hanif et al., 2018).

In 2015 it was shown that Indonesia had low scientific achievement with 64 out of 72 countries participating Program International Students Assessment (PISA) (Kemendikbud, 2016 in Hanif et al., 2018). PISA questions consist of problem solving questions that require problem solving through analysis and critical thinking. The results of these data indicate that the critical thinking ability of Indonesian students is in the low category because the learning carried out so far generally focuses on conceptual and theoretical questions so that it cannot trigger and develop students' critical thinking (Hanif et al., 2018).

This is in line with Saputra & Kuntjoro (2019) that learning Biology is often faced with various problems. One of them is that the teacher conveys the concept of learning material directly

which makes students less active in learning so that the value of learning outcomes obtained is less than optimal. In this case, Biology learning does not only emphasize understanding concepts but also in authentic problem solving processes. This requires teachers to guide students to practice higher-order thinking skills is critical thinking skills.

Currently, students are faced with big challenges, which must learn more complex material and the demands of higher-order thinking skills that must be achieved, meaning that they are not only competing in the field of intelligence, but also in terms of creativity and intelligence to act (hard skills-soft skills). According to Dewi (2015) in the world of education, the success of a student is not only seen from his academic ability, but also from the abilities and skills that can help students to compete in the global and digital world that is developing today.

In the context, learning is based on constructivism learning theory, the intention is to build students' understanding of new knowledge. According to Facione (2015), experts agree on the meaning of critical thinking and critical thinking ideas. Facione states, understanding critical thinking as a self-regulation drive through interpretation, analysis, evaluation, inference such as explaining based on evidence, concepts, methodological, criteria or contextual considerations.

Wahyuni (2015) in Sanjaya & Evie (2021) suggests that critical thinking is an idea or way of thinking to understand a problem comprehensively, being able to think openly to the views and decisions of others, also accompanied by a serious effort to understand and evaluate the information obtained when going to make decisions and can relate cause and effect in solving problems that exist in learning activities or everyday life.

Mawar et al. (2020) state that critical thinking is highly emphasized in the learning process so that critical thinking skills are needed in solving life problems they face, this is in line with Phan (2010); Ennis (2011) in Zahroh & Yuliani (2021) that critical thinking skills is defined as a person's reflective thinking process that focuses on deciding the right thing to do or solving problems in various situations and opportunities in real life.

Students use critical thinking to observe and analyze pictures or graphs, ask questions about the given learning material or correlate experimental results. In addition, students also need critical thinking to solve problems and answer the questions given (Ulandari, 2018 in Ariq et al., 2021).

Critical thinking skills include the ability to access, analyze, synthesize information that can be learned, trained and mastered. According to Zubaidah (2016), critical thinking skills also describe other skills such as communication and information skills, as well as the ability to examine, analyze, interpret and evaluate evidence. In this digital literacy era, the flow of information is very abundant and widespread, therefore critical thinking skills are needed by students in choosing relevant sources and information in the learning process at school, interpreting every source found, selecting and sorting out quality and reliable sources make an assessment of the truth of the source of the object obtained.

Critical thinking skills can be trained if supported by learning that can encourage students to think critically. Learning is carried out well when accompanied by a good lesson plan. Therefore, learning tools are needed that support students critical thinking skills (Wulandari, 2017 in Hanif et al., 2018).

According to Sofiana et al. (2021), 21st century skills are not only implemented in the learning process but also in teaching materials, one of the teaching materials used in the teaching and learning process is the Student Worksheet. Therefore, in developing the Student Worksheet teaching materials used by teachers and student, they must also implement 21st century skills in which children can think creatively, critically, collaborate and communicate.

The current Biology learning regarding Student Worksheets is generally only used at certain times, for example in the sub-chapters that are practiced. The Student Worksheet used in the practicum as a practicum guide containing identities, tools and materials, objectives, work procedures and conclusions. The rest of the Student Worksheets are only contained in learning tools, so that learning does not seem interesting to students. The use of Student Worksheets in learning can be alternative for teachers to direct learning or introduce a particular activity. Student Worksheets are able to become learning tools that shorten the time in delivering learning topics (Fithri et al., 2021).

Astuti et al. (2018) stated that Student Worksheets are teaching materials that are packaged in such a way that students can study the material independently, so that students become more active in solving existing problems through group discussion activities, practicum and problem-answering activities relate to everyday life. These make students more challenged in the process of learning activities than learning that is

only one-way. The problem-solving activities contained in Student Worksheets can later have an impact on improving their way of thinking, including critical thinking.

Meanwhile, according to Mawar et al. (2020), Student Worksheets can develop students thinking skills and train students to work objectively and can play an active role in finding concepts in the learning process. Likewise Anggraini (2016) in Mawar et al. (2020) that the Student Worksheet contains summary material and assignments that are able to stimulate student activities to master the material in the learning process activities.

The problem that often occurs is the use of Student Worksheets that have not been able to maximize the learning process in achieving learning objectives. The Student Worksheet is made with the aim of helping students find a concept their through practicum or theory. Student Worksheets, which during circulation only contain a summary or review of the subject matter, contain practice questions. The Student Worksheets used in schools today are less able to train students to carry out the investigation process.

Student Worksheets with short answer do not provide clear examples of completion; do not meet the requirements, designs that are less attractive and innovative. Even though it is given in the form of an assignment, the nature of the task is only one problem solving. Just as the Student Worksheet invites students to think systematically, this can be done if students are given complex tasks in one bill. Researchers only use one sub-skill from several sub-skills in each critical thinking skill. Ideally each sub-skill of critical thinking uses all sub-skills. If the above conditions are met, the learning that is mandated to fulfill 21st century thinking skills in education can be achieved.

Student Worksheets that contain critical thinking skills are absolutely necessary, so that students have cognitive skills in everyday life. In addition, Student Worksheets based on critical thinking skills can also train students' abilities and explore critical thinking, so as to improve student learning outcomes and performance.

The choice of the Coordination System concept was mainly due to the lack of research on the development of Student Worksheets on the concept. In addition, the concept of the Coordination System is abstract, so it has a fairly high level of difficulty and complexity of the problem and the concept Coordination System needs to be raised because it is closely related to the structure of the organ making up the network in the coordination system as well as disturbances that can occur in the human coordination system.

Based on this, a development research was carried out on the Biology Student Worksheet for Senior High School based on critical thinking skills on the concept of the Coordination System with the aim of describing the validity of the Student Worksheet which was developed based on critical thinking skills about structure and function as well as disturbances in the coordination system, especially the senses.

## B. Material and Method

This teaching materials research is included in educational design research, namely EDR (Educational Design Research) with reference to the formative evaluation of Tessmer's (1993) design. The stages used in this research are a) self-evaluation and b) expert test.

The first stage is the self-evaluation stage, in this study, the teaching materials to be developed are Student Worksheets on the Coordination System concept, the first stage is collecting Student Worksheets on the Coordination System concept from previous studies as many as 4 pieces and analyze their weakness and strengths after being analysed, the next step is to develop the Student Worksheets by designing the cover to its contents, then aligning it to fit the 2013 curriculum and critical thinking skills.

The next stage is an expert test which will be carried out by two lecturers of Biology Education FKIP ULM Banjarmasin. The results of the developed Student Worksheet designs are submitted to a team of experts for validation. Validation by a team of experts uses a validation instrument that contains eight aspects, namely the design of the Student Worksheet the truth of the content (facts, concepts, principles, laws, theories and scientific processes), systematic, linguistic, presentation, format, systematics of the Student Worksheet (Daryanto & Dwicahyono, 2014) and a bibliography that will be assessed by 2 expert teams.

The scoring is set with a maximum score of 4 (very valid), the component that gets a score of 3

means that the researcher makes improvements according to the suggestions and inputs given by the expert team before obtaining the maximum score. Improvements to the components that scored less were handed back to the expert team to get the final score of the repair results and calculate the total validation score using the average method.

Calculating the validity of the Student Worksheet according to Sugiyono (2013) uses the formula:

$$X = \frac{\Sigma X}{N}$$

Description:

X = Final validation score

ΣX = Average number of validity each aspect of LKPD

N = Number of LKPD aspects

**Table 1 Validity criteria**

Score	Validity
4	Very valid
3 - < 4	Valid
2 - < 3	Sufficiently valid
1 - < 2	Invalid

(Adapted from Nur (2013), in Arbainsyah, 2016)

After going through the validation stage and the validity score according to the validity category, the Student Worksheet can be used in learning, this is in line with Sugiyono (2013), namely a product that has been developed and has gone through the validation stage, and then the product can be used as teaching material.

## C. Results and Discussion

Research on the development of Student Worksheets on the Coordination System concept has produced 4 topics, namely the results of the validation of Student Worksheet data can be seen in the following table 2, and validator suggestion in the table 3. Based on the data in the table above, the results of the validity of the Student Worksheet which were tested by two validators, obtained an average score of 3,41 which was included in the valid category.

**Table 2 Validation results**

No.	Aspect	Worksheet version				Total score
		I Score	II Score	III Score	IV Score	
1.	Worksheets Design	3,50	3,50	3,50	3,50	3,50
2.	a) Content truth (facts, concepts, prinsiples, laws, theories dan scientific processes)	3,50	4,00	4,00	3,50	3,75
	b) Systematics	4,00	4,00	4,00	4,00	4,00
3.	Language	3,00	3,00	3,00	3,00	3,00
4.	Presentation	3,00	3,50	3,00	3,00	3,125

No.	Aspect	Worksheet version				Total score
		I Score	II Score	III Score	IV Score	
5.	Format	4,00	4,00	4,00	4,00	4,00
6.	LKPD Systematics (Daryanto & Dwicahyono, 2014)	3,00	3,00	3,00	3,00	3,00
7.	Bibliography	3,00	3,00	3,00	3,00	3,00
<b>Rata-rata</b>		<b>3,37</b>	<b>3,50</b>	<b>3,43</b>	<b>3,37</b>	<b>3,41</b>
<b>Category</b>		<b>Valid</b>	<b>Valid</b>	<b>Valid</b>	<b>Valid</b>	<b>Valid</b>

**Table 3 Suggestions from Validators**

Comment	Repair
The background color doesn't match the text	Customized background color
There is an inscription that is too small	Enlarged text
There are words that are not clear	Sentence error has been fixed

The development of a device is based on a strong theory, namely that there is an interrelationship between the components in the device being developed, then the learning device can be said to be valid (Istiqamah, 2019). According to Desmiwati (2017), a quality Student Worksheet has high validity.

The design of the Student Worksheet has been completed with a preface, table of contents and cover so that it has a valid category. Making the cover of this Student Worksheet has been arranged in such a way to make it look more attractive. The cover illustration serves to attract reading interest in addition to being an advertising language that invites students to be interested in working on the Student Worksheet. In this case, the cover of the Student Worksheet is in accordance with the material discussed regarding the coordination system so that the relevant picture is presented on the material.

The systematic writing of the developed Student Worksheets has been systematic. The average score obtained in this systematic aspect is 4,00. In the aspect of writing, it gets a high average score because the writing of the Student Worksheet that has been developed is in accordance with the guidelines.

Language is an aspect that gets an average score of 3,00, this is because there are still errors in the writing of the Student Worksheet, through minor revisions, the linguistic aspect in the Student Worksheet is appropriate and there are no errors in writing and has corrected words or sentences that are not standard. For excellence in the linguistic aspect itself, in the Student Worksheet that was developed, it was already using good and correct Indonesian and was easily understood by students after going through minor revisions.

According to Faridah (2019), the language eligibility component obtained very valid criteria, because in the preparation of the Student Worksheet, the language used is in accordance with the level of students thinking development, this can make it easier for students to understand learning.

In the aspect of the format obtained an average score of 4,00. The assessment format that emphasizes the writing of the Student Worksheet developed is aligned in using the type and size of letters (except table if any), spaces, bold letters, italics, underlines and colors.

The aspect of presentation that emphasizes whether the Student Worksheets used can stimulate motivation/curiosity as well as interesting or not with photos that are known by students, displaying images that are easy to understand and interesting.

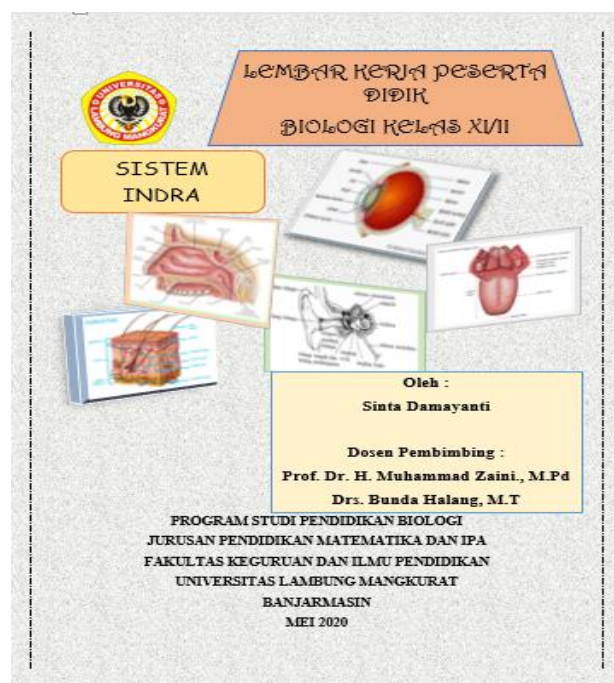


Figure 1 Coordination System Studen Worksheet Cover

In the bibliography aspect, it has an average score of 3,00 from the validation results by the two validators. The advantages of this aspect in the developed Student Worksheets are that there are discourses as reading material in the Student

Worksheets, in addition to the discourse; a web address is also listed as additional knowledge for students because they can find answers to the questions in the Student Worksheet.

The Student Worksheet on the concept of the Coordination System developed overall can be said to be valid, because the components in the Student Worksheet are consistent with the 8 aspects contained in the validity instrument. However, the scores obtained are valid and have gone through the stages of improvement according to the validator's suggestions and have been corrected by the researcher. The aspects that have been repaired presented in table b. the suggestions given by the validator help in improving the Student Worksheet is worthy of being tested for the next stage.

## D. Conclusion

Based on the results of validation by two validators, the validity of developing the Student Worksheet on the concept of a critical thinking skill-based coordination system is declared valid.

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