Learning tool development of guided inquiry based to reduce of student’s mistake in resolving question on cell division concept

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Abstract. This study aims to produce learning tools using the guided inquiry model which is reasonable to reduce misconception in students’ class XII for solving problems ability on the cell division concept. This development research refers to Borg and Gall development which was modified. The collected data were analyzed qualitatively and quantitatively. Validity data using content validity ratio formula by Lickert Scale. Data of learning feasibility, students’ activities, and student responses conducted on observations. Data obtained from pre and posttest which are used to assess student learning outcomes, were analyzed using the normalized gain formula. The results of the study showed that learning tools (lesson plan and worksheet) are developed showed on minimum valid criteria. Practicality aspect of developed learning tools show good criteria was observed from the learning feasibility, students’ activities and responses. The effectiveness aspect showed high criteria based on N-gain was observed from students’ learning outcomes. This result shows that learning tools are developed qualify on validity, practicality, and effectiveness aspect and can use to measure learning quality to reduce students’ mistake in solving problems ability in the concept of cell division.

1. Introduction
The term learning refers to an activity that is carried out independently and with the responsibility to master a particular competence, skills, and other aspects focusing on gaining experience and changes. Morgan in Suryabrata [1] argues that “Learning is any relatively permanent change in behavior that is a result of experience.” The success of learning is determined by quality instructional media. Nazarudin [2] defines instructional media as materials that the teacher should design individually or in the group to have systematical learning and evaluation; this is also to ensure that the learning goal is achieved.

Instructional media comprise lesson plan and student worksheets, based on approaches emphasizing the integration of goals/competences, materials, learning activities, and evaluation [3]. Students in understanding the concepts learned can be made easy as is worksheet. Majid [4] defines the term “student worksheet” as assignments that the students must accomplish. In the worksheets are instructions and guidelines for the students to work on an assignment; the assignment basically measures the achievement of a particular standard competence.

Biology is among the subjects taught in a school which aims at developing the students’ competence in understanding some aspects of life, i.e., the interaction of living being with nature and the way the living being survives. The subject also functions as a basis for other sciences, such as medical, agriculture, pharmacy, health, law, and others. Good learning motivation is required to learn
this subject as it is able to improve the students’ learning and promote some aspects, e.g.,
systematical, logical, critical, and creative thinking skills.

An interview with teachers and students of class XII sciences of SMA Negeri 1 Limboto Barat has
been implemented. It was aimed at exploring the learning and classroom activities in the site. It is
revealed that the school uses the same lesson plan every year. On top of that, the interview indicates
some other issues, such as lack of students’ engagement during the class, unavailability of worksheets
that support the learning, in conducive learning situation, as well as monotonous and uninteresting
activities. The students find it difficult to work on assignments especially those related to figures and
terminologies. As a result, the students are unable to satisfy the standard of the basic competence of
the lesson, specifically in discussing cell division material. This is based on the result of the
evaluation where some of the students only score below the minimum completion standard (80).
Furthermore, the percentages of the students’ learning outcome in the last two years, i.e., the
academic year of 2015/2016 and 2016/2017 are 60% and 45% respectively.

In response to the above issue, instructional media involving based on guided inquiry model have
been designed. These media help the teacher and students in learning as well as minimize mistakes
that the students make in working on tasks. Minstrel et al [5], National Research Council [6], and
National Teachers Association [7] recommends that inquiry-based learning approaches in natural
science subjects. Anam [8] further argues that ... it is better for a teacher to implement guided-
approach to students that never been exposed by the inquiry approach. Similarly, Astuti [9] proposes
that “students would benefit much from guided-inquiry learning as the learning model allows them to
participate in the class actively and find concepts through their own construction.”

Implementing guided-inquiry learning in biology subject is able to promote high-level thinking
skills of the students. This learning model also helps the students to respond to a particular problem
scientifically and therefore discover their own solutions. Colburn [10] defines “inquiry-based learning
as ‘the creation of a classroom where students are engaged in essentially open-ended, centered,
hands-on activities.” Ozmen [11] further delineate that inquiry-based learning involves a set of
activities, including observation, asking questions, finding and using the information to comprehend
phenomena in an experiment, as well as using tools to collect, analyze, interpret data, explaining,
predicting, and disseminating the result.

The problem statement of this research is how is the quality of the instructional media based on
guided inquiry learning to reduce mistakes of students in working on a test of cell division material; it
refers to the validity, practicality, and effectiveness of the developed instructional media. This
research is aimed at developing the instructional media based on guided inquiry learning to reduce
mistakes of students in working on a test of cell division material; it refers to the validity, practicality,
and effectiveness of the developed instructional media.

2. Methods
2.1 Research design
This research is developmental research, a research design that is mostly used in addressing practical
issues in education. It refers to research and development model by Borg [12] that has been modified
by Sugiyono [13]; However, this research stopped at the stage of assessment.

The designed instructional media were being validated by three experts in the fields suit the needs
of this study, which aims at producing a draft of instructional tools that will be used during the trials.
As many as ten students participated in a limited trials. The objective of these trials is to identify the
practicality and effectiveness of the instructional media.

2.2 Data collection method
The data were generated from observation on several aspects, i.e., implementation of learning,
students’ activities, responses and their learning outcome.

2.3 Data analysis
The data of assessment by the validators were analyzed through processes in the following Table 1.
The results of the analysis of the practicality of the instructional media were obtained from the observation of the learning implementation, students’ activities and responses were analyzed by calculating the percentage learning implementation, percentage of students’ activity and percentage of students’ responses to learning.

3. Result and Discussion

3.1. Validity analysis of instructional tool

The assessment results on the lesson plan and student worksheets by expert validators.

3.1.1. Validity Analysis of Lesson Plan.

The validation results on guided-inquiry-based lesson plan in the lesson cell division revealed that the guided-inquiry based lesson plan is considered valid despite varied differences of a perfect score, i.e., 50. Nevertheless, the data of the conversion depicted on the table shows that the average score from all three validators is in the range of > 42.02 or 43.67. Such a score indicates a valid result once it converses on the table of qualitative data criteria. Widyoko [14] asserts that a valid lesson plan can guide a teacher during classroom learning.

3.1.2. The validity of students’ worksheets.

The validation results on guided-inquiry-based students’ worksheets in the lesson cell division revealed that the guided-inquiry based students’ is considered valid despite varied differences in the score and perfect score, i.e., 225. The average score of the validation test on student’s worksheets is in the range of > 189 or 198.67. The conversion of such score into the criteria of qualitative data as shown in the table emphasizes the validity of the students’ worksheets. Dwiyanti [15] argues that good students’ worksheets can help the students to work on assignments.

3.2. Analysis of the practicality of instructional tools

The results of the analysis of the practicality of the instructional tools are based on several aspects, e.g., learning implementation, students’ activities, and responses.

3.2.1. Observation results of learning implementation.

The results of observation of the implementation of the learning in limited trials are depicted in the average score of the implementation of a guided-inquiry lesson plan on grade XII science of SMA Negeri 1 Limboto Barat is 79.34; this score represents the major field test. In other words, 85.5% of the learning procedures are effectively implemented by the teachers. There are, however, several concerns that should be addressed during the learning, such as inaccuracy and the unsystematically conduct of learning. Teachers are also unable to provide best solutions to the problems the students face. In addition, the teachers find it challenging to guide student groups in formulating a hypothesis on the students’ worksheets.

The results of observation of the extensive trials of the implementation of the learning to show the average score of the implementation of a guided-inquiry lesson plan on grade XII science of SMA Negeri 1 Limboto Barat is 83.44; this score represents the major field test. In other words, 99.3% of the learning procedures are successfully implemented by the teachers. The observation reveals a
significant, positive contribution of guided-inquiry learning to the scientific skills and learning outcome of the students. This resonates the results seen in research on the impact of such a learning model towards the students’ learning in discussing a lesson salt hydrolysis by Octadhia [16]. Another advantage of inquiry learning is that the learners are guided to develop their knowledge actively in investigative-based learning. This further promotes learners’ skill in reasoning and broadening their insight regarding scientific concepts Khalid, et. al [17], dan Smynalou, et. al [18].

3.2.2. Observation results of students’ activity.
The results of observation of the limited trials of the students’ activities are depicted in the overall average score of the guided-inquiry-based students’ activities variable reaches 76.75 or 91% in its qualitative data criteria equivalent. In other words, the students’ activities variable is in a good category. The result of the observation on 21 aspects shows a number of issues, i.e., lack of teacher’s guidance in group learning as well as the inability of the student groups in several stages of observation, including finding, formulating a problem statement, proposing a hypothesis and all the way to the data analysis process. Another problem is that limited time that the group has to present their works.

Guided inquiry learning model is applicable in the lesson of cell division due to its advantages. This model helps the students to promote their scientific attitudes, e.g., observing, predicting, proving, analyzing data, and drawing up conclusions. Martin [19] argues that “… the types of activities that the students do in inquiry-based learning are close to what actual scientists do in the real world. These include asking questions about the world around them, gathering evidence, and providing explanations”. The notion refers to a set of activities that the students do, ranging from generating questions regarding surrounding phenomenon, collecting proofs and explaining the phenomenon much to a researcher do in real life.

3.2.3. Students’ responses.
Information regarding the students’ responses about the implementation of guided-inquiry-based learning media reveal that 95% of them agrees and strongly agree to the implementation of guided-inquiry worksheets in learning. This asserts that all the students are interested and highly support the use of new worksheets, particularly in discussing a lesson about cell division. On the other hand, students whose response is different seem to be unenthusiastic and act passively during guided inquiry learning.

3.3. Analysis of the effectiveness of instructional tool
The effectiveness of the instructional media can be seen from the results of the assessment of students’ worksheets and students’ evaluation.

3.3.1. Results of assessment of students’ worksheets to reduce students’ error during working on a test.
The results of the assessment on the worksheets based on the limited trials are shown in two groups of student have a significant score in the second and third meeting. In the second meeting, the worksheets focus on the sub-topic of mitosis cell division. The score of group 1 and 2 regarding this topic is 75.89 and 96.43 respectively. This reveals that mistakes frequently occur in group 1, there are even basic mistakes that the group 1 made. Some examples are inaccuracy to match the process of mitosis cell division, ranging from arranging set of images of interphase all the way to cytokinesis, drawing the patterns of every phase of cell division, naming the phases, and determining the correct characteristics of the cell division based on a figure given.

Incorrect answers by group 1 also occur in group 2. However, the difference between both groups’ score takes place in the third meeting with sub-topic of meiosis cell division, in which group 1 scores 95.04, while group 2 scores 80.17. The incorrect answers made by group 2 within this sub-topic is observable in the data of observation result.

The answers result from students’ worksheet indicates that it is essential to enhance the learning process of Mitosis and Meiosis Cell Division sub-topic; this is to encourage the students to be more meticulous in choosing the correct picture in accordance with cell division, and that the students are able to draw the accurate illustration of patterns of cell division phases and differentiate the
chromosome activity within every phase. Moreover, by the enhancement, it is expected that the students can grasp the comprehensive concept of different characteristics of cell division phases that depend on the cell activity.

The implementation of inquiry-based learning and developed students worksheet about cell division is effective in enabling the students to explore complex problems by the teachers and in triggering their abstract thinking of discovered concepts, thus making the learning process effective. Moreover, by the implementation of the worksheet, students can synthesize discovered concepts comprehensively, interpret a phenomenon, and perform effective decision-making.

The guided inquiry-based learning involves problems given by the teacher to be solved by the students. These tasks are capable of developing students’ problem-solving skills by applying the obtained knowledge to the problems, on top of that, the implementation of the tasks assists the teacher in concept understanding. This is in line with Uno [20] who point out that by implementing tasks, students are brought into the concrete realm of concept understanding. Therefore, students can actualize the learned concepts and perform more effective learning outcomes.

3.3.2. Students’ learning outcome.

The students’ learning outcome by utilizing guided inquiry based learning media during the limited trials to show there are eight students who pass the minimum learning mastery while two do not pass; with a total average score of 76.49 or 80% in classical percentage. As observed from the figure, the criteria of classical learning mastery results in good criteria, moreover, the error analysis of students’ score (low, average, high) refers to the criteria of final test in regard to the minimum passing grade applied in the school. Baharuddin [21] assert that the test for learning outcome is one of the knowledge aspects to measure the achievement of students’ competence in accordance with learning indicators.

Based on the test result of students’ learning outcome in the limited trials, the study extracts the gap of increase in students’ learning outcome between pre-test and post-test, as displayed in Table 2 as follows.

| Test Class       | Average pre-test score | Average post-test score | Average N-Gain score | Category    |
|------------------|------------------------|-------------------------|----------------------|-------------|
| Limited Trials   | 0.72                   | 76.51                   | 0.76                 | Very High   |

It is depicted in Table 2 that there is the difference between average score prior to the treatment and after the treatment, therefore, it is found out that the N-Gain average score of 0.76 and categorized very high, by average (g) of above 0.70 (0.70 < g < 1.00).

The implementation of guided inquiry learning has proven effective and provides meaningful learning experiences for students with excellent learning outcomes. The notion is in accordance with Limbach et.al [23] that point out that active learning provides meaningful experiences and stimulates students’ cognitive development. Henceforth, it signifies that the product of the lesson plan and students’ worksheet developed by engaging guided inquiry model is effective to be implemented to the students.

4. Conclusion

Instructional media developed by this research have met the requirements of validity, practicality, and effectiveness as a measure of the quality of a learning model. The implementation of guided inquiry-based learning is proven capable of reducing errors made by students in answering questions during the test to measure learning outcomes.

Further researchers are recommended to carry out students’ errors in solving problems with different learning strategies. Teachers are expected to provide guidance to students to the new learning model, particularly in being time-efficient to solve problems and present the result of group discussion to the class.
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