Developing Maple-Assisted Worksheets in Statistical Physics Course

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Abstract
Students have difficulty understanding the material of statistical physics because of the characteristics of them which have a mathematical basis as differential, integral, exponential, and statistical equations. For this reason, it is necessary to design a companion learning textbook that can help students in learning mathematical equations in a statistical physics material. The purpose of this study was to determine the validity and practicality of the maple-assisted worksheet in statistical physics course. The type of research is research and development (R & D). This research consists of three stages, namely the defining, the design, the development stage. The research instrument used was a validation sheet to measure the validity, and a response questionnaire to measure the practicality of student worksheets. The prototype of a maple-assisted worksheet was validated by two validatory. The validation results show that the student worksheet is highly valid. The results of the limited trial of 30 students in the statistical physics course showed that the maple-assisted worksheets in the statistical physics course were highly practical from aspects that were easy to use, interesting, and efficient.

INTRODUCTION

In physics, something is learned by first separating the object of inquiry into a system and everything outside the system is called the environment. In explaining the state of a system there is two aspects, namely the microscopic and macroscopic aspects. Statistical Physics is a part of physics that applies a microscopic view, that has characteristics such as the supposition that a system consists of some molecules and quantities that are detailed and cannot be measured (Viridi & Khotimah, 2010).

Statistical Physics is one of the compulsory subjects in the physics department. The expected learning achievement in this course is that students can comprehend the concepts and theories of statistical physics,

implement and communicate them coherently and systematically (Fisika, 2016). Therefore, lecturers are required to be able to guide students to achieve the objectives of this lecture.

However, the reality in the field that researchers encountered was different. Based on the experience of the researcher teaching statistical physics, not all students can achieve the lecture goals as expected. Many students find it difficult to comprehend statistical physics lecture material which includes probability, distribution functions, kinetic theory, and statistical mechanics. This is because, besides having to understand the physical meaning, students must also be able to solve mathematical equations. If the mathematical settlement is not correct, it will cause the wrong physical meaning. Thus, lecturers is how to mix lectures

so that students can become more aware of the lecture material.

A lecturer can do many ways to enable students to become more familiar with lecture material. Like by developing teaching materials as student worksheets (Rohadi, 2013; Tandililing, 2015). Student worksheets are one alternative source of learning that can help students and lecturers in lecturing statistical physics. Worksheets are usually as instructions, steps to complete a task. Worksheets contain not only questions that require students to answer them but also contain concepts that help students learn lecture material.

The characteristics of statistical physics material which have a mathematical basis as differential, integral, linear, exponential, and statistical equations require that the learning resources used can help students solve mathematical equations and draw conclusions on the physical meaning of the natural phenomena contained. So we need a tool to solve the mathematical equation and visualize it. One way is to use maple software help, as has been done by (Tandililing, 2015) who developed mathematical maple to improve mathematics physics lectures. Maple is a mathematical computer-based algebra software that can solve equations as numerical and symbolic solutions. Maple also has computational and visualization capabilities, with ease of use and support facilities for mathematical operators, mathematical functions, and fully integrated mathematical solutions (Tung, 2005).

Maple was created and developed by Waterloo Maple inch. We can instal maple on Windows or Macintosh operating systems (Tung, 2005). So that we expect that the existence of a maple-assisted student worksheet in statistical physics courses can help improve students' understanding of statistical physics material. Based on the respect for, the researcher tried to provide an alternative for lecturers in statistical physics by developing a maple-assisted student worksheet for the material on the subject of statistical physics.

METHOD

The research method is research and development (R & D). The research and development steps carried out using the 4-D method, which consists of Define, Design, Development, and Distribution according to Thiagarajan and Semmel in (Trianto, 2010). This paper is until the development stage.

1. Define

At this stage, it carried an analysis of development needs out (establishing and defining learning requirements). The major steps that must be taken at this stage are: a) Front-end-analysis); b) learned analysis; c) task analysis; d) concept analysis; and e)specifying instructional objectives.

2. Design

Based on the results at the defining stage, we then carried the design stage out. I did this stage to design and prepare a prototype of a maple-assisted worksheet in the statistical physics that will be developed. We divide this stage into four steps, namely : a) constructing criteria - referenced test; b) media selection; c) format selection; and d) initial design.

3. Development

After the prototype was complete, we carried the development stage out. At this stage, experts validated the validity of the product, lecturer in computer mathematics applications and lecturer in statistical physics. The suggestions provided by the validatory were used to improve the product.

Then at this stage continued by testing the product prototype that has been produced, called the practicality test. When testing the product, data is obtained as inputs or criticisms for product improvement and then tested again until it gets valid and practical results to use. We conducted limited trials on students taking statistical physics courses in odd semester 2018/2019.

RESULTS AND DISCUSSION

Result

The results are a prototype of a maple-assisted student worksheet in a statistical physics subject. The following describes the characteristics of student worksheets assisted with maple in the statistical physics course that has been designed:

1) We designed the cover of a student worksheet with maple design as attractive as possible and adapted to the material in the statistical physics

course. Following is the cover on the worksheet in Figure 1.

2) We equip student worksheets with instructions for using worksheets. This guide contains guidelines for using worksheets for lecturers and students. The following is the instructions page for using the worksheet in Figure 2.
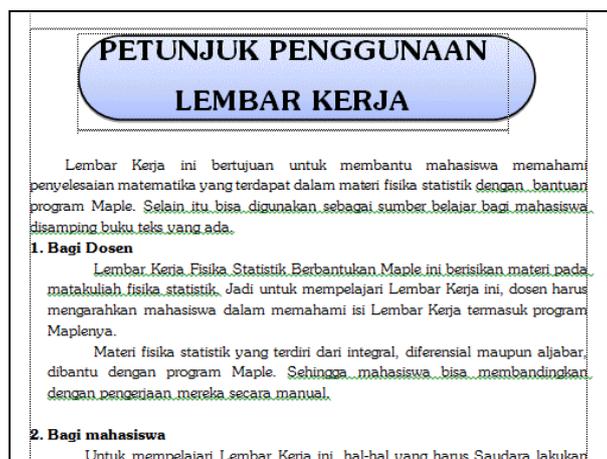

Figure 1. The Cover of The Student Worksheet.

Figure 2. Instructions Page for Using Student Worksheets

3) Before entering activity sheet 1, we equipped this student worksheet with the material "*Thinking Maple*". This section contains the operating methods of the maple program starting from installing, starting work on the worksheet, and using helpful tools on maple. The display of the maple thinking section is in Figure 3.

4) In the first part of the activity sheet on the worksheet, we equipped the student with the title of the activity sheet, the title of the material, the learning outcome, the expected last abilities, and the study material. The font type used in the activity sheet is Lt Bt Souvenir size 11. As shown in Figure 4.

5) Material Summary: The contents of the material summary are adapted from several statistical physics textbooks. A summary section of material that requires the completion of mathematical equations such as integrals, solved with the help of maple (As shown in Figure 5).

6) Example of a "maple think" problem: this section is an example of a problem in each summary of the material where the mathematical equation is solved using maple assistance. In solving the problem of this example, we can use a tool that is already available in the maple program. An example of a "maple think" display is shown in Figure 6.
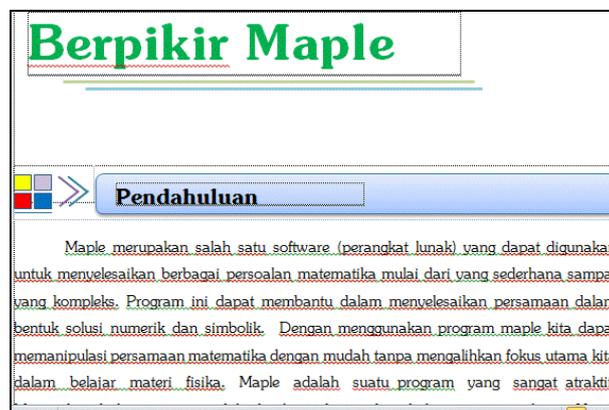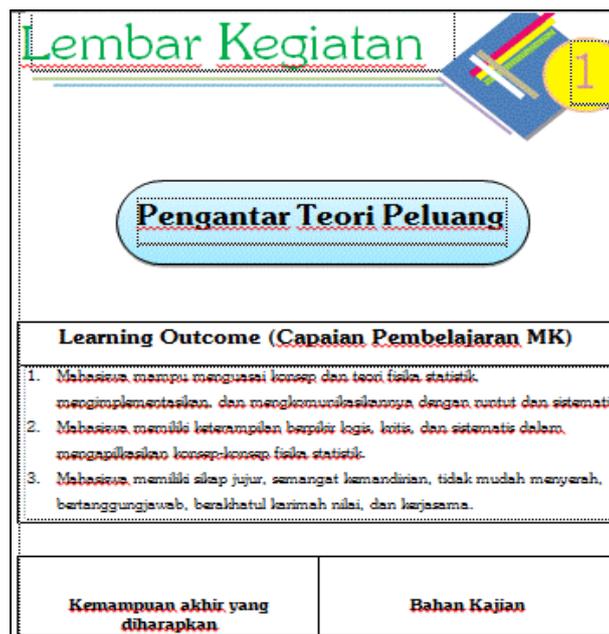

Figure 3. Thinking Maple on Student Worksheets

Figure 4. Preliminary Display of Activity Sheets on Student Worksheets

Figure 5. Example of Display of Summary Section of Material for Completion assisted by Maple

(a)

(b)

Figure 6. Display of "*Maple Think*" Sample Questions on Maple Assisted Student Worksheets in Statistical Physics
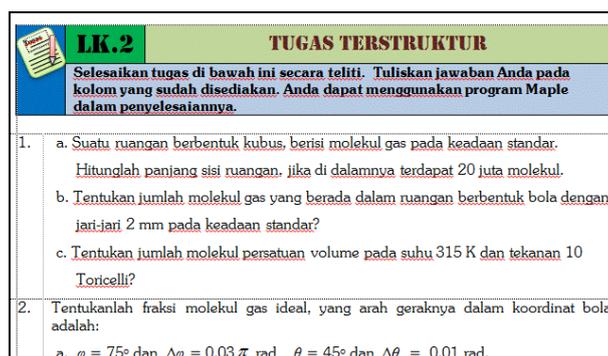
Figure 7. The Display of Structured Task on Student Worksheets

Table 1. The Results of The Validation of Maple Assisted Worksheets in Statistical Physics Courses

NO	The Validation Aspects	Validator		Max Score	Score (%)	Category
		1	2			
1	Content	32	31	72	87.5	Highly Valid
2	Presentation	41	42	88	94.32	Highly Valid
3	Language	14	16	32	93.75	Highly Valid
4	Graphics	19	18	40	92.5	Highly Valid
	Totally score	106	107	232	91.81	Highly Valid

7) We also equipped this student worksheet with structured assignments and sheets to answer assignment questions. Completion of tasks may use maple help to help students understand each material. Examples of display of structured tasks as shown in Figure 7.

8) We also equipped this student worksheet with an attachment that contains some special integral solutions. So that students can compare with the results obtained with the help of maple.

Validation of Maple Assisted Student Worksheets in Statistical Physics Courses

We conducted the validation phase after they completed the worksheet. Validation is carried out by two validatory using the instrument validation sheets. Validation is carried out by two validatory using the instrument validation sheet. Assessment of the validation sheet based on the textbook assessment indicators (BSNP, 2013). Suggestions and comments from the validity are taken into consideration for the improvement of student worksheets that have been designed so that a valid worksheet with maple help is

produced. Data from the validation of student worksheets assisted with maple in the overall statistical physics course can be seen in Table 1.

The average score of the results of the validation of student worksheets assisted with maple in the statistical physics course by the validity is 91.81%. According to the criteria of the assessment by experts (Riduwan, 2011), it was found that the student worksheets assisted with maple in the statistical physics course were highly valid. So we can use this worksheet product for the practical stage.

The Practicality of Maple Assisted Worksheets in Statistical Physics Courses

The practicality of the worksheets designed seen through trials is limited to 30 students majoring in physics. In this trial, I asked students to read and study student worksheets and then asked students to fill out the responses questionnaire provided. We can see the results of processing the response questionnaire in the appendix. In general, we can see the results of the student response questionnaire in Table 2.

Tabel 2. The Questionnaire Results of Student Response to Maple Assisted Worksheets in Statistical Physics Courses

No	Practical Aspects	Total Score	Max Score	Percentage	Category
A	Easy to Use				
1.	The existence of instructions for using a maple-assisted statistical physics worksheet makes it easy for students to use Worksheets	109	120	90.83	Highly Practical
2.	The maple-assisted statistical physics worksheet helps students understand statistical physics concepts.	99	120	82.50	Highly Practical
3.	The material presented on this worksheet is clear and easy to understand.	98	120	81.67	Highly Practical
4.	The existence of a maple think column on the presentation of material and sample questions helps students understand statistical physics material	103	120	85.83	Highly Practical
B.	Interesting				
5.	The maple-assisted statistical physics worksheet has an interesting appearance.	98	120	81.67	Highly Practical
6.	The composition of images and colors in a statistical physics worksheet assisted by maple is interesting to read.	98	120	81.67	Highly Practical
7.	Maple-assisted statistical physics worksheets can increase attractiveness and stimulate students' curiosity in learning concepts and solving abstract statistical physics problems.	105	120	87.50	Highly Practical
C.	Efficient				
8.	Presentation of maple program assistance on worksheets can replace manual counts which are usually done with mathematical calculators and tables.	114	120	95.00	Highly Practical
9.	The learning approach with the help of the maple program used in this worksheet can save time in lecturing statistical physics in the classroom.	113	120	94.17	Highly Practical
10.	Activities on the worksheet can be carried out by students individually and in groups.	105	120	87.50	Highly Practical
	Average			86.83	Highly Practical

Based on Table 2, we saw that maple-assisted worksheets are categorized as highly practical, with an overall average of 86.83%.

Discussion

Based on (BSNP, 2013), a product is valid if it meets four criteria, namely: content feasibility, presentation feasibility, linguistic feasibility, and graphic feasibility. From the results of the validation presented earlier, it shows that the student worksheets assisted by maple in statistical physics courses are a highly valid category in terms of content feasibility, presentation feasibility, language feasibility, and graphic feasibility.

Student worksheets assisted with maple in statistical physics courses are highly valid based on the results of the validity's assessment because: The eligibility of the contents is in a highly valid category. This is because the worksheet developed is by the demands of learning outcomes and the expected last abilities. The material presented outlines the minimal substance that supports the entire achievement of the learning outcome. The statistical physics concepts presented are following the truths of science because they come from quality sources. The illustration of the maple program used is also correct. According to (Prastowo, 2012) also stated that if used in the worksheet material came from various sources (such as books, the

internet, or research results journals), then this would be very good.

In the component relevance of the contents of the worksheet, the statistical physics material contained in the worksheet is following the development of students, we structured the task questions according to the explanation in the material description. This is following the things that need to be considered when designing a worksheet, namely the level of ability of students and the knowledge of students expressed by Belawati (Prastowo, 2012).

The feasibility of presenting student worksheets assisted by maple is very valid seen from the completeness of the presentation, presentation of information, and presentation of learning. The presentation of the worksheet is following the format of the student worksheet that has been set. Like the beginning of the worksheet that contains explicit instructions for use. Translation of material involving integrals, differentially assisted by an explanation using maple. We also equipped each material description with examples of problems that are solved using the help of a maple program so that it can assist students in understanding the material of statistical physics.

The language feasibility of student worksheets assisted with maple in statistical physics courses is highly valid in terms of language accuracy and conformity with student development. The sentence used to convey the message refers to good and correct Indonesian grammar, is the sentence is short, using active, clear sentences. Following what was revealed by (Prastowo, 2012), the sentence presented should not be too long. The point is simple, clear, and effective. Thus, participants in the school will easily understand it.

The feasibility of charting student worksheets assisted with maple in statistical physics courses is highly valid in terms of size, cover design, and worksheet contents. (Prastowo, 2012) states that the material and target audience. influenced and determined paper size For this student-assisted maple worksheet, the appropriate paper size is A4 size, because it will make students more clearly study the material and be free in writing structured task results on the worksheet. The font size (font) used on the worksheet is read. The layout and layout on the worksheet are also proportional. The display design of the cover and the contents

of the maple-assisted student worksheet also interest the reader.

The Practicality of Maple Assisted Worksheets in Statistical Physics Courses

Based on the practicality analysis carried out, we found that student worksheets assisted by maple in statistical physics courses were in the very practical category. We see this practicality from the aspect of ease of use, has appeal and efficiency. This is in line with the opinion (Sukardi, 2009) which states the practicality of a product viewed from the aspect of ease of use has appeal and efficiency.

Based on student comments on the questionnaire given, the maple program on the student worksheet is very helpful and makes it easy for them to calculate math calculations that are difficult to do manually. This is because the maple program helps users in solving equations in the form of numerical and symbolic solutions. Also, maple has computational and visualization capabilities that maple users (Tung, 2005 can easily use). By using the maple program users can manipulate mathematical equations easily without shifting the primary focus to learning physics material. Besides, the student worksheet is instructed how to use the worksheet and instructions for using maple. Although the instructions for using maple are not so detailed, basic things like opening a program, writing operations, and commands in maple are given at the beginning of the worksheet making it easier for students to use maple on this worksheet.

Then students are very enthusiastic about learning examples of questions given because by using this Worksheet students can compare the results obtained manually with the results in maple. Before using this maple-assisted worksheet they had to find manual counts and help with mathematical table books. Of course, it takes a long time to get results. Using maple programs can help students to solve problems quickly (Setyani, 2006). As well as the curiosity of students to be high to find the results of calculations on the examples of questions given.

CONCLUSION AND SUGGESTION

Conclusion

This research has produced a student worksheet assisted with maple in a highly valid

and practical statistical physics course, with the following details: 1) Maple-assisted worksheet in statistical physics courses are highly valid according to 2 validatory in terms of the feasibility of content, presentation, language, and graphics with an average score of 91.81%, 2) The results of the trial are limited to 30 students who are taking statistical physics courses obtained by a maple-assisted worksheet in a very practical statistical physics subject in terms of readability for easy-to-use, interesting, and efficient aspects.

Suggestion

1. Maple-assisted worksheet in statistical physics courses can be used as a companion learning resource for statistical physics textbooks.
2. For further research, we can test this worksheet for effectiveness.

AKNOWLEDGMENT

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