

Developing Economic-Mathematics Learning Worksheets during Covid-19 Pandemic

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Abstract

The science of mathematic is applicable in economic field to resolve problems based economic. The purpose of this study is to develop valid and practical worksheet criteria in economic-mathematics course. Employing the development study of design research method, this study encompasses three main steps namely the preliminary, prototyping, and assessment step with formative study being used as an evaluation flow in the prototyping step. The subjects of this study were fourth semester students of a university in Karawang. The data were gathered through documentation, walkthrough, questionnaire, test, and interview. Based on the data analysis, it was concluded that this study has delivered seven valid and practical worksheets products on seven different economic-mathematics course materials.

Keywords: Economic-mathematics, Worksheet, Development Research.

1. Introduction

Mathematics is a science that has specific function as an analysis tool. It is practical in many fields including economics to support the economic-related problem solving. This is in accordance with the definition of mathematics stated by Kline (Marlina & Ruhiat, 2018) who defined mathematics as a tool for human needs in facing social, economic needs, and in exploring the secrets of nature. The existence of mathematics can make it easier for someone to understand economics which is modeled in a mathematical function as an implication of existing theories (Marlina & Ruhiat, 2018). Thus, mathematics is expected to meet human needs in various aspects such as social, economic and other needs.

The economic-mathematics is one of elective courses offered in Mathematics Education Department in Singaperbangsa University Karawang. As a consequence of a dense material, there are considerable amount of materials being applied in this course. Based on observation conducted by Wahyudin (2017), students tend to have lack of understanding in solving economic-mathematics problems that leads to students' inability to identify and apply the approaches as well as strategies in solving the problems. Students are also incapable in making mathematical modelling such as transferring story question-based problem into mathematical statements.

In order to develop the students' potential optimally, active teaching and learning activity that emphasizes on students' involvement to experience, discover, and solve the problems is required. However, the educational system is faced with the current situation of Covid-19 pandemic which demand teacher to master remote learning media. Almost all teachers do the

remote learning; thus, interactions between lecturers and their students happen directly and indirectly (Yensy, 2020). The study result from Loviana & Baskara (2020) revealed the negative impacts on online learning during the Covid-19 pandemic in Mathematics Education Department in IAIN Metro Lampung as such the lack of students' understanding on learning materials, and teachers' inability to evaluate and assess students' understanding comprehensively and optimally.

Another point of remote learning shortcoming in learning economic-mathematics is that students could not actively involved in the argumentation process while teachers deliver the argumentation steps explanation directly both in using virtual and actual printed learning materials. Thus, students' activities are limited to memorize the concept and take notes while learning. This kind of students' learning activity is in contrast with the constructivist psychology of learning which endorse students to construct their own knowledge through their observations, assumption makings, problem solving, and conclusion drawings (Syam & Yunus, 2020). Therefore, the need to design a learning that can involve students' actively, improve students' creativity and students' thinking patterns to construct their own knowledge autonomously is undeniable.

The autonomous economic-mathematics concept discovery process is guided through tertiary students' worksheet (Lembar Kerja Mahasiswa so called LKM). According to Trianto, (Ramadhona & Izzati, 2018) the tertiary students' worksheet (LKM) is a guide for students in investigating and problem-solving activity. Prastowo explained that student worksheets (LKM) are sheets of paper in which their use are varied depend on the teaching materials containing materials, summaries, and instructions of learning tasks that students need to complete, both theoretically and practically which refer to the competencies that students must achieve (Syam & Yunus, 2020). Based on the definition of LKM, it appears that students' worksheets have a very important role in supporting learning which requires students to be autonomous, responsible, and actively participate in lecturing sessions.

Based on the above definition, the use of students' worksheets has several advantages such as: (1) endorse students' active participation in the teaching and learning process, (b) assist students in developing concepts, (2) guide students to discover and develop the teaching and learning process, (3) help lecturers in compiling lessons, (4) as a guideline for lecturers and students in carrying out the learning process, (5) accommodate students in obtaining notes about the material being studied through learning activities, (6) encourage students to collect more information about the concepts learned through systematic learning activities (Pasandaran, Kartika, & Masni, 2017).

2. Method

This study used the development study of design research method (Akker, et al., 2006; Nieveen & Plomp, 2007). This method is a form of research with a qualitative approach. The design research is a systematic study of designing, developing and evaluating educational interventions such as programs, strategies and learning materials, products and systems as solutions to solve complex problems in educational practice (Plomp & Nieveen, 2007). The

research includes preliminary or preparation stage, prototyping stage and assessment stage (Nieveen & Plomp, 2007). At the prototyping stage, the evaluation flow was carried out using formative evaluation which includes self-evaluations, expert reviews, one-to-one, and small groups' evaluation.

At the self-evaluation stage, the researchers evaluated the design of economic mathematics worksheets in economic mathematics course activities. The design process applied three characteristics, namely, content, construct and language. These three characteristics were validated by the researchers themselves. The analyzed result of this processes was then become the first prototype of the worksheet in economic-mathematics course.

At the expert review stage or expert test, the generated products were validated by experts. The products were being examined, assessed and evaluated. The expert validation used content, construct and language analysis. The experts referred to in this research were experts in mathematics education, linguists and economists. The first prototype validation process in the expert review stage was carried out in three ways, namely face-to-face review, mail (mail review), and panel trial (Tessmer, 1993). The results of the expert review were then used to revise the product. Along with the expert review, the researcher tested the students individually (one-to-one). The results from one-to-one were used to revise the product to be made. From the results of expert reviews and one-to-one, the second prototype was generated.

The small group stage was carried out after the expert review and one-to-one were conducted with the results of the second prototype. This stage was carried out to determine the valid and practical criteria of the prototype that has been designed. There were 12 students involved in this stage who were not the subjects of the research that had been selected. The students involved in this stage were students with different competences.

Based on the research method, the data collection techniques used were documentation, walkthrough, and questionnaire. In the self-evaluation stage the document used was the campus curriculum in which the researchers designed a worksheet using the content, construct and language characteristics to obtain the first prototype. In addition, documentation process was also carried out in the form of photos and videos to facilitate the research. Several photos were taken to capture important moments while research was conducted. Meanwhile, walkthroughs were carried out with experts or mentors at the expert review stage to evaluate the results of self-evaluations by providing input, comments or suggestions related to the content, constructs and language in the first prototype. Furthermore, researchers made improvements based on the consideration of all suggestions and comments from the experts. The questionnaire was administered at the one-to-one stage and the small group was used to find out student comments and suggestions on economic mathematics worksheets. The questionnaire given at the one-to-one stage was an open questionnaire to find out student comments and suggestions given as revision material. At the small group stage, the questionnaire given was open and closed questionnaire to see the practicality of the worksheets on the prototype which includes attractiveness, convenience, and usability (Effendi, et al, 2019).

3. Results and Discussion

This study is about the development of economic mathematics worksheets in economic mathematics courses for fourth semester students. The results of this study are in the form of seven economic mathematics worksheets developed in two subjects, namely the sequences and series and the application of linear equations in economics. At the preliminary stage, the discussions and interviews were carried out with the team of lecturers for Economics Mathematics and 5th semester students to find out the lecturing process in the courses and to find out the students' capability in economic mathematics courses. Based on the results of the interview, it was concluded that the economic mathematics courses had not used worksheets for learning and that students' abilities in economic mathematics courses were heterogeneous.

This stage begins with the analysis of series and sequences and linear functions materials which divided into six sub-chapters materials, namely Single Interest (simple), Compound Interest, Annuity, Demand Function, Supply Function and Market Balance. Based on the sub-chapter, the worksheets were arranged according to learning outcomes: (1) Students are able to understand and solve economic problems related to series and sequences of three economic problems, namely single interest and compound interest, the present value of simple interest and compound interest, and annuities. (2) Students are able to understand and solve economic problems related to linear functions with three economic problems, namely the demand function, supply function, market balance and consumer, producer, and total surplus. Afterward, the researchers made the first prototype draft of economic mathematics worksheet.

In order to correct the errors that appeared in the self-evaluation phase, the first prototype that has been compiled by the researchers was re-evaluated before carrying out the next phase. The evaluation on the first prototype focused on content, construct and language.

The expert review and one-to-one phases were conducted to validate the first prototype that had been designed beforehand. The first prototype was also tested on three students as testers (one-to-one). The selection of three students at this stage is in accordance with the formative evaluation guidelines to produce substantial changes to the worksheets that have been made (Tessmer, 1993). The three students were asked to read and answer questions to see the students' understanding and responses. Table 2 shows the questions for the interview (Aini, et al 2018).

Table 1. Interview Questions

Number	Question
1	Do you know the meaning of the question?
2	Using your own words, can you tell me what the problem is in the question?
3	Do you think the information in the question can be used to solve the problem?
4	Have you ever encountered a problem like this before?

From the interviews, it was found that most students understood the questions and directions in the worksheets being developed. Furthermore, in the expert review, the researchers asked the opinion of experts and colleagues who had experience in mathematics and economics education. The experts are Economics Lecturers at the Faculty of Economics, University of Serang Raya, and colleagues are fellow lecturers in Economic Mathematics course in Mathematics Education FKIP UNSIKA. Responses and suggestions from the experts and colleagues about the prototype design were written on the validation sheet as revising material and to declare the worksheet's validity.

Table 2. Experts and Colleagues' Comments

No	Name	Comments
1.	Validator 1	The worksheet design is good in general. Suitability of the contents and constructs with economics courses is good. Suggestion: Level of the problems need to be elevated
2.	Validator 2	The worksheet design corresponds with the desired learning outcomes in economic-mathematics course.

Perhatikan ilustrasi di bawah ini!

Salah satu tempat pengrajin anyaman rotan mendapatkan jumlah permintaan hasil anyaman sebanyak 250 buah jika harganya Rp50 per anyaman. Sedangkan pada tingkat harga ini, pengrajin hanya bersedia menawarkan anyamannya sejumlah 90 buah. Pada setiap kenaikan harga sebesar Rp60 maka jumlah permintaan akan menurun sebanyak 150 buah, tetapi jumlah penawarannya bertambah sebanyak 390 buah.



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Figure 1; Correction in Worksheet 7

Figure 1 show the changes based on respondents' comments on improper and ambiguous words such as "increasing as much as" becomes "increasing to be". Comments were given at the one-to-one stage to validate the first prototype which has been tested on three fifth semester students, namely: IP, AHS and ARA. The purpose of this trial is to find out the students'

responses and difficulties in reading and answering questions on the worksheet. The focus of the responses and difficulties being observed were readability and clarity of the worksheet and the questions on the worksheet. Meanwhile figure 2 shows the changes based on students' comments in the year that are not in accordance with the sentences in the previous statement by changing from 2030 to 2027.

Pak Gibran adalah seorang kepala keluarga berpenghasilan tetap setiap bulannya. Ia berencana untuk menyiapkan dana pensiunan di hari tua nanti. Dari penghasilannya, Pak Gibran menyisihkan Rp15.000.000 setiap akhir tahun untuk ditabung di bank, dimana pembayaran tingkat bunga 5% per tahunnya secara majemuk. Pak Gibran memulai menyisihkan penghasilannya dari tahun 2020 hingga akhir tahun 2027.

Sementara itu, di tahun 2021 Pak Gibran juga berencana untuk mencicil mobil selama 12 kali angsuran atau 1 tahun. Mobil tersebut seharga Rp90.000.000 dengan tingkat bunga 6%, dan Pak Gibran sudah membayar DP 40% di muka.

Dari ilustrasi di atas, jawablah pertanyaan-pertanyaan berikut!

1. Berapakah dana pensiun yang dihasilkan Pak Gibran selama menabung dari tahun 2020 sampai tahun 2030?

Pak Gibran adalah seorang kepala keluarga berpenghasilan tetap setiap bulannya. Ia berencana untuk menyiapkan dana pensiunan di hari tua nanti. Dari penghasilannya, Pak Gibran menyisihkan Rp15.000.000 setiap akhir tahun untuk ditabung di bank, dimana pembayaran tingkat bunga 5% per tahunnya secara majemuk. Pak Gibran memulai menyisihkan penghasilannya dari tahun 2020 hingga akhir tahun 2027.

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Figure 2; Correction in Worksheet 3

The developed Economic mathematic worksheet was validated through *one-to-one* and *expert review*. This process is in accordance with Krathwohl (1997) who stated that triangulation is the process of using more than one source to confirm information: confirming data from different sources, confirming observation from different observers, and confirming information with different data collection methods. Triangulation is a data validation technique by utilizing something other than experts and students' work as a comparison/basis for revising assessment instruments. Valid aspects are associated with texts developed based on strong theoretical rationale and internal consistency (Akker, 1999). Fraenkel and Wallen (2010) asserted that the validity test is conducted to make sure that the instruments being developed generate appropriate, meaningful, precise, and useful information for the researchers in drawing conclusion. Based on one-to-one stage result and expert review, it is revealed that Economic Mathematics worksheets for economic mathematics courses are valid except for worksheet 3, since the worksheet 3 was perceived to be too difficult and inapplicable by the respondents.

The revised Prototype 1 in the expert review and one-to-one stage is addressed as prototype 2, which were tested afterward at the small group stage consisting of 6 students from D class of 2018, namely MIQ, IAR, VPP, CP, MRA and PE. At the Small Group stage, respondents were asked to read and answer questions on the worksheet and were asked to provide suggestions and comments on texts and questions that have been read and answered.

Table 3. Respondents' Comments

No	Name	Comments
1	MIQ	In general, the worksheets have addressed clear objectives for each material and learning outcome. In the worksheet 1, it is not clear to me whether Pak Rosda and Pak Sultan made investment annually or only once in every four years period. In worksheet 4 and 6, it is also uncertain whether the number used in computation should be converted into thousands or should just leave it as stated in the question. There are also some difficult questions for me to solve it by myself without discussing with fellow students such as question number 5 and 6 in worksheet 4 and 5.
2	IAR	In my opinion, the questions in the worksheets are clear and easy to understand. However, there are some questions harder than others to understand and to determine which equation to be used. As for the worksheets assigned are easy in general since there are some identical and related questions in terms of the way it is solved.
3	VPP	The questions in the worksheets are clear enough, unless for several questions are harder to comprehend and to specify which equation to be used to solve the problems. Other than that, some questions are easy since there are some related questions and some questions with similar way to solve it.
4	CP	All worksheets are clear enough for me except for worksheet 3. There are some ambiguous statements in the worksheets, yet, the statements and questions in worksheet 3 are hard to understand. There are also some mistyping errors such as in the worksheet 1, the information about single and compound interest, in the worksheet 2 about present value of simple and compound interest, in the worksheet 3 about annuity, in the worksheet 4 demand function, in the worksheet 5 about offering functions, in the worksheet 6 about market balance, and in the worksheet 7 about consumer, producer, and total surplus.
5	MRA	There are some tricky and confusing questions for me. Maybe because I did not really understand it. The questions in the worksheet 3 and 7 should be made easier because the material/problem being delivered is quite challenging. What a good thing if the questions given are those taken from the easiest level of questions.
6	PE	These economic-mathematic worksheets are beneficial for me.



Pak Rosada dan Pak Sultan setelah mendapatkan bonus tahunan dari perusahaannya berencana untuk menginvestasikan uang bonus tersebut di bank sebesar Rp.20.000.000. Meski berencana bersama, tetapi mereka tidak bersama-sama menyetorkan uangnya ke bank. Ketika sudah empat tahun berlalu, mereka bersama-sama ke bank untuk mengambil uang investasinya. Saldo yang diperoleh Pak Sultan lebih besar dari Pak Rosada, dan pegawai bank menjelaskan rincian mengapa keduanya memiliki saldo yang berbeda padahal bunga yang didapatkan sama yaitu 7% setiap tahunnya. Berikut tabel rincian investasi Pak Rosada dan Pak Sultan yang terakumulasi selama 4 tahun.



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Figure 1; Editorial Revision

Figure 3 shows changes from the second prototype to the third prototype which developed based on the comments from respondents in the worksheet 1 on the story-question part, "After getting an annual bonus from their company, Pak Rosada and Pak Sultan plan to invest their bonus of Rp. 20.000.000 in the bank". The 'annual' word in the sentence makes the story ambiguous since it has impacts on answers to numbers 3, 4, and 5. Should the story be changed, the word 'annual' in the question will be removed.

"Practically refers to the extent that user (or other experts) considers the intervention as appealing and usable in normal conditions", (Akker, 1999). In developing the Economic Mathematics worksheet, practicality is shown through students' interests and both its' usefulness and convenience for students. Based on the questionnaire result, the percentage of the interest aspect was 82%, the usability aspect was 90%, and the convenience aspect was 87%. Practicality is seen as the main quality since an impractical assessment will not necessarily last for a long time, no matter how valid, and reliable it is (Yanjin, 2018). A practical product offers the users a comfort in using the product so that the product can last a long time (Effendi, et al, 2020). Referring to the small group stage results, the Economic Mathematics worksheets for economic mathematics courses are identified to be practical. With the worksheets containing contextual problems related to casual economic problems encountered by students, it has made it easier for students to understand mathematical concepts on economic problems. The use of contextual problems can increase students involvements in learning, thus students have better conceptual understanding (Madrazo, dio, 2020).

In solving the worksheet on the offer function material, students easily understand economic problems of masks selling with various motives. It is because the context of masks selling is relatable with the current conditions as we all face the Covid-19 pandemic and are mandated

to use masks in various activities. In addition, the questions have guided students to understand the function of the offer as it use more simplified language and are arranged orderly from the easiest to the harder questions.

7) Kesimpulan :
 Fungsi penawaran dengan fungsi linier dipengaruhi oleh faktor Harga dan Jumlah yang ditawarkan (P dan Qs). Semakin tinggi harga maka semakin banyak jumlah produk yang ditawarkan untuk dijual dan sebaliknya.

Figure 4; Student Answer

Figure 4 shows that students can provide correct conclusions about the supply function. This answer is in accordance with the law of supply, if the price increases, the amount offered will increase and if the price falls, the amount offered will decrease (Dumairy, 2017). When students are given practice questions related to the offer function, their answers indicate their positive ability to complete them. One of the questions given in the worksheets was about the sale of durian, it is illustrated that Pak Rohim's sale of durians at a price of Rp.30,000 was only 100 durians, and when the price of durian was Rp. 40,000 Pak Rohim sold more than 200 durians. Then, the students were asked to explain whether or not Pak Rohim increases his durian sales when the durian price falls to Rp. 20,000 per piece.

Latihan soal
 ① Ketika harga durian Rp. 20.000 Pak rohim tidak akan memperbanyak penjualan durian. Dalam fungsi penawaran apabila terjadi penurunan harga maka semakin sedikit jumlah durian yang ditawarkan.

Figure 5; Student Answer

The figure 5 shows students can answer the question accurately about Pak Rohim's durian sales when the durian's price falls to Rp. 20.000. This indicates that students are able to understand the offer function concept correctly that Rp. 20,000 is a reduction price from the previous prices of Rp. 30,000 and Rp. 40,000. The students who have understood the concept of the offer function are able to solve problems in various situations such as in durian sales. The students' ability to understand mathematical concepts is noticeable once students can transfer conceptual ideas to various occurring learning situations (Choung et al, 2018).

4. Conclusion

Based on the research results, the generated products are in the form of worksheets for economic mathematics course consisting of six valid and practical worksheets from two courses materials. The materials included are about series and sequences, and linear equation of economic mathematics. The validity of the worksheets is described based on the validator's assessment in terms of content, construct, and language being used. Meanwhile, the practicality

is defined by the results of the small group stage test which include three practical aspects of the worksheets namely convenience, usability, and interest.

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