Developing of STEM based learning models for economic education student for facing Industry revolution 4.0 in East Java

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Abstract. The Government of Indonesia has established Making Indonesia 4.0 to deal with R.I 4.0. To realize this, education should also develop strategies for achieving quality education. Quality education can be realized by increasing the skills possessed by a teacher. In this case, economic education includes students who will become teachers. To become a professional teacher requires special skills in RI 4.0 era. STEM is an acronym for science, technology, engineering, and mathematics. The purpose of this study is: 1) develop STEM-based learning models for students of economic education in East Java in the face of the R.I Era. 4.0; 2) decide the effectiveness of the implementation of STEM-based learning models for students of economic education in measuring teacher skills in the R.I era 4.0. The method consists of 1) Potential and Problems; 2) Gathering information; 3) Product design; 4) Design validation; 5) Design improvements; 6) Product trials; 7) Product revision; 8) Trial usage; and 9) Product revisions. The results of this study are: 1) STEM-based learning models can be implemented and in accordance with the characteristics of R.I 4.0 and 2) This model is effective in increasing the skills of students of economic education in the R.I 4.0 era.

1 Introduction

The education system continues to be improved by the Indonesian government. One element that can increase the contribution of education in the economy is the teacher. Teachers as the frontline in preparing millennial generation who have competence and competitiveness in the industrial era 4.0. Referring to Law article 10 Number 14 of 2005 concerning Teachers and Lecturers which states that every teacher must have four competencies, namely pedagogical competence, personal competence, social competence and professional competence that can be used to support the government program Making Indonesia 4.0. In line with the changing phase of the Industrial Revolution that has entered

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Industry 4.0, all teachers must respond and follow the qualifications needed in this era. Teachers must have qualifications in this era that emphasize data-based knowledge, technology, and humanism not only the basic abilities they have so far.

As a teacher in the era of RI 4.0 gave birth to a term known as Teacher 4.0 Challenges & Requirements. To become a teacher 4.0 must have 3 components, namely: 1) Human-Based & Didactical Challengee; 2) Organizational Challengee and 3) Technological Challengee [1]. With the existence of these skills as a student who will later become a professional teacher must also prepare his ability to organize education by the vision of Learning in the Period of Industrial Revolution 4.0. This research was conducted at three universities that have Economic Education study programs, namely Universitas Negeri Malang (UM), Surabaya State University (UNESA), and Jember State University (UNEJ). In addition to the abilities needed by Economics Education Students, the ability to be creative and innovative in choosing and designing learning models is also needed. One of them is the STEM-based learning model.

The advantages of this STEM-based learning model can be known as an article entitled Making sense of STEM Education in K-12 context [8], namely Two important things that are rarely discussed in the literature of the STEM learning model are about the technology used by students and the potential of subjects that can be implemented in the STEM model to access and get opportunities for students to participate in the model. This learning model is also very compatible with the characteristics of economics. Like the article titled "Towards the STEM DBER Alliance: why we need a discipline-based STEM education research community [6] which states that Discipline-based education research (DBER) is a term that describes research that discusses the learning and teaching of science that uses a variety of methods in-depth with the priority of science and practice. DBER develops evidence-based knowledge and practices to improve teaching and learning through the STEM model.

2 Research Method

This type of research used by researchers is a case study in which researchers will emphasize an in-depth analysis of the readiness of prospective Economics teachers in facing the phase of Industrial Revolution 4.0. Researchers describe or describe the complete information provided by research subjects from observations and interviews conducted by researchers, thus this research will later contain data excerpts and documentation from informants who provide an overview of the actual situation. From the results of these interviews a STEM learning innovation model will be developed that can support the readiness of prospective economics teachers to face the Industrial Revolution Era 4.0.

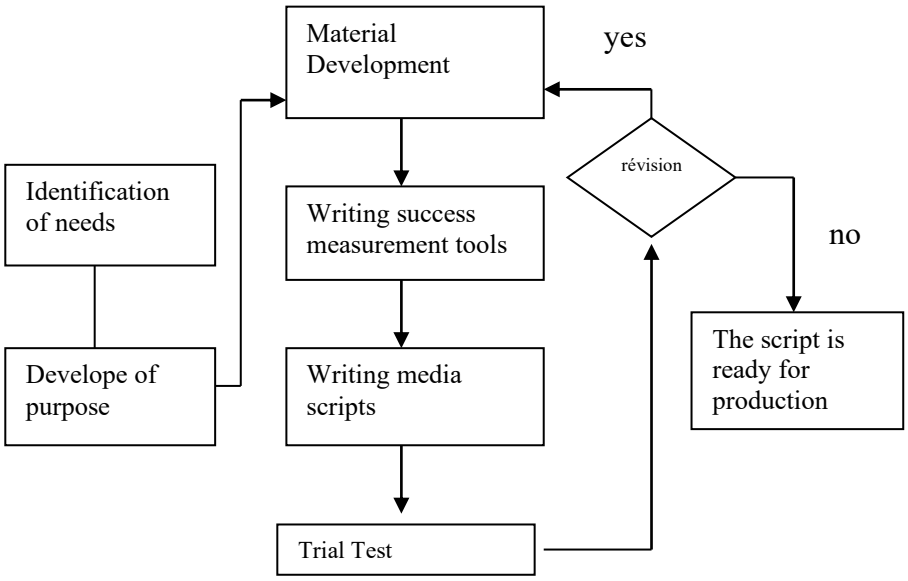

Chart 1: The steps of developing research

Based on these pictures it can be seen that in conducting this research there are 10 steps, namely: 1) Research and gathering initial information, 2) Planning, 3) Development of initial product formats, 4) Initial trials, 5) Product revisions, 6) Field trials, 7) Product revision, 8) Field test, 9) Final product revision, 10) Dissemination and implementation.

3 Result and Discussion

The results of data retrieval in East Java which is one of the provinces that have a reputable State University in Indonesia certainly produces the best graduates who will later contribute to the development of national education. The State Universities are Universitas Negeri Malang (UM), Surabaya State University (UNESA) and Jember University (UNEJ) as Teaching State Universities that produce professional teacher candidates. This is proven by the courses presented in this Study Program by the competencies required by prospective Economics teachers, one of which is the Learning Strategy course. The courses at UNESA have also been designed to prepare prospective Economics teachers where one of the courses given is Innovative Learning to form students in the Economic Education Study Program at UNESA as innovative teacher candidates in preparing their learning. Like the two campuses, the UNEJ course also presents a Learning Planning course which is a guide course for a teacher in developing learning tools that are carried out. In developing the STEM-based learning model, it was carried out by conducting a preliminary study in the form of a questionnaire that discussed competencies in the period of the industrial revolution 4.0 which consisted of Human-Based & Didactically Challenges; Organizational Challenges; and Technological Challenges. Also, the questionnaire covered STEM-based learning in RI 4.0 era. This was obtained based on the perception of students of economic education at the three campuses. The results can be seen in the diagram below.

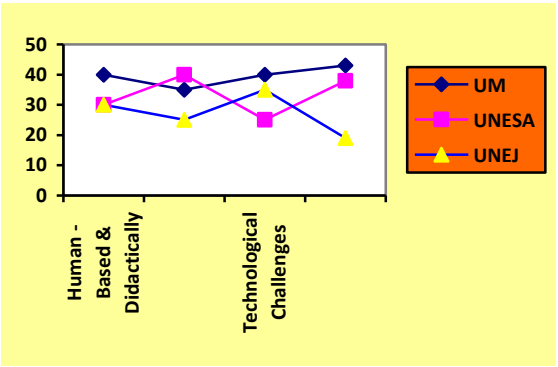

Fig. 1. Economic education perception of teacher performance in RI 4.0

Based on the table it was found that the highest Human-Based & Didactically Challenge competencies were at Universitas Negeri Malang (35%); The highest Organizational Challenges were at Surabaya State University and Universitas Negeri Malang (40%); and the highest Technological Challenges at Universitas Negeri Malang (43%). It also saw the readiness to do the STEM learning model. These results obtained include UM by 43%, UNESA by 38%, and UNEJ 19%.

The perception was made by the team in developing the STEM-based learning model based on the highest score, which was conducted at S1 Economic Education Study Program Students at the Universitas Negeri Malang. The following is a picture of 2 photos of the activities of one of the Bachelor of Economic Education students who practice STEM-Based Learning Models on the topic of Market Balance.

Fig. 2. STEM model in economic education

Fig. 3. One of the first character in the STEM process

The development of STEM-based learning models can be done with the steps below:

a. *Asking questions and defining problems*

In the first stage, students are motivated to make observations of market conditions in a micro context such as an increase in prices of basic commodities for consumers and what their effects on the market are like. This is followed by finding questions from a phenomenon and students are motivated to be able to solve existing problems and try to clarify them.

b. *Developing and using models*

In the second stage, after making an observation and obtaining information about various phenomena related to science (microeconomics about price variables), students will then carry out the stages of developing and using models or examples. Where this step is, students are asked to be able to see through models and simulations to help develop the information being observed.

c. *Planning and carrying out investigations*

In this third stage, students are asked to plan and conduct scientific investigations to obtain data related to changes in prices of basic commodities in the market (traditional markets and modern markets).

d. *Analyzing and interpreting data*

At this stage, after students conduct scientific investigations and obtain data, the data obtained are then analyzed and then interpret the data obtained.

e. *Using mathematics and computational thinking*

In the next stage, students use mathematical thinking and computational thinking to build simulations and analyze data. Through this stage, students must create a demand and supply function based on data before the change and after the price change. Besides that, from the model found, there will be a correlation between the price of goods and the number of goods in balance.

f. *Constructing explanations and designing solutions*

At these stages, students must be able to build explanations related to learning activities that are being studied. Then able to design new solutions to problems found in learning on the topic of market balance.

g. *Engaging in argument from evidence*

Students involved in argumentation to clarify existing learning concepts are then able to provide the best solution to a problem that is reinforced with data evidence to maintain a conclusion.

h. *Obtaining, evaluating, and communicating information*

At this last stage of the data collected students are able to evaluate and communicate information appropriately.

Developing STEM-based learning models can improve teacher competency in S1 Economic Education students. This can be seen from the average test score of the Pedagogy Exams given by researchers. The results can be seen in Figure 4 below.

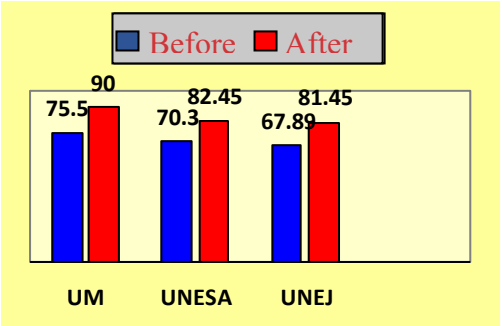

Fig. 2. Pedagogy score in each economic education student

Based on figure 4 we can find out that it is through the STEM-based learning model that can effectively improve the pedagogical abilities of S1 Economic Education students. We can see that the improvement is 14.5 in Universitas Negeri Malang (UM), 12.15 in Surabaya State University (UNESA), and 13.56 at Jember State University (UNEJ).

From the results obtained by developing STEM-Based Learning is able to improve the competence of S1 Economic Education students as specific teacher candidates as in terms of solving a problem that demands critical thinking by combining the criteria of Science, Technique, Engineering, and Mathematics. This is in line with research conducted by [15] entitled Supporting Improvements to Undergraduate STEM Instruction: An Emerging Model for Understanding Instructional Change Teams whose results are group input from instructional changes provides a variety of results. So it can show the change leader to talk about productive things when starting with a new group or overcoming challenges with an existing group.

4 Conclusion

From the discussion we can conclude that: 1) STEM-based learning models can be implemented and in accordance with the characteristics of R.I 4.0 and 2) This model is effective in increasing the skills of students of economic education in the R.I 4.0 era.

References

1. A. Abdelrazeq, 9th annual International Conference of Education, Research and Innovation. Proceedings (2016) DOI: 10.21125/icerl.2016.0880.
2. A. Prastowo, *Method of Qualitative Research in the Research Design Perspective*. (Yogyakarta, Ar-Ruzz Media, 2012) [in Bahasa Indonesia]
3. BPS of East Java Province (2017), *Higher Education in East Java*, URL : https://jatim.bps.go.id [in Bahasa Indonesia]

4. R. Davies (2015), *Industry 4.0 Digitalisation for productivity and growth*, URL : http://www.europarl.europa.eu
5. H. Firman, Seminar Nasional Pendidikan IPA dan PKLH, (2015)
6. Henderson et al, International Journal of STEM Education **4(11),** (2017) DOI 10.1186/s40594-017-0076-1
7. S. Heng (2014). *Industry 4.0: Upgrading of Germany's Industrial Capabilities on the Horizon*, URL : https://ssrn.com/abstract=2656608
8. Holmlund et al, International Journal of STEM Education **5(32)** (2018) https://doi.org/10.1186/s40594-018-0127-2
9. T. Huseno, Jurnal Elektronik Riset Ekonomi Bidang Manajemen dan Akuntansi Sekolah Tinggi Ilmi Ekonomi Galileo, Vol. **2** No. 2 (2018) [in Bahasa Indonesia]
10. H. Kagermann, W.D. Lukas, & W. Wahlster (2011). *Industrie 4.0: Mit dem Internet der Dinge auf dem Weg zur 4. industriellen Revolution*, URL : http://www.vdi-nachrichten.com
11. Kemendikbud (2017), *Accelerated and Even Quality Education*, URL : https://www.kemdikbud.go.id [in Bahasa Indonesia]
12. Kemenristekdikti (2018), *Announcement of Indonesian University Clusterization*, UR L : http://kelembagaan.ristekdikti.go.id [in Bahasa Indonesia]
13. Kemristekdikti, *Technical Pantigan Performance Indicators for the Development of Science and Technology Center for Excellence in 2017*. Jakarta: Direktorat Jenderal Kelembagaan Iptek dan Dikti. (2017) [in Bahasa Indonesia]
14. Kemristekdikti (2018a), *Science and Technology Development and Higher Education in the Industrial Revolution Era 4.0*, URL : https://www.ristek-dikti.go.id [in Bahasa Indonesia]
15. Olmstead et al, International Journal of STEM Education. (2019) https://doi.org/10.1186/s40594-019-0173-4
16. M.R. Payong, Teacher professional certification (basic concepts, problems and their implementation. Jakarta: PT. Indeks (2011) [in Bahasa Indonesia]
17. Regulation of the Minister of National Education of the Republic of Indonesia No. **16** of 2007 concerning Academic Qualification Standards and Teacher Competencies, (2007) [in Bahasa Indonesia]
18. H. Prasetyo, S. Wahyuni. Jurnal Teknik Industri, Vol. **13** No. 1. (2018) [in Bahasa Indonesia]
19. Rohard (2010), *STEM Based Education, URL :* https://rohardonline.com [in Bahasa Indonesia]
20. C.M. Rubiho, Ensayos. **33**, 2171- 9098. (2010)
21. K. Schwab, *The fourth industrial revolution*. Crown Business Press. (2017)
22. H. Subekti, et.al, Education and Human Development Journal, **3(1)**, 81`90. (2018) [in Bahasa Indonesia]
23. Sugiyono. Quantitative, Qualitative, and R&D Research Methods. Bandung: Alfabeta (2016) [in Bahasa Indonesia]
24. Sukanti. Jurnal Pendidikan Akuntansi Indonesia, Vol. **VI**, No. 1. (2008) [in Bahasa Indonesia]
25. World Economic Forum (2016), *The Future of Jobs Employment, Skills, and Workforce Strategy for the Fourth Industrial Revolution*, URL : http://www3.weforum.org