KnE Social Sciences

IRCEB
International Research Conference on Economics and Business
Volume 2021

Knowledge E
enriching | engaging | empowering

Conference Paper

# Development of STEM-Based Evaluation Tools for Economic Learning in SMA East Java in the Education Era 4.0

**Sri Handayani, Sri Umi Mintarti, Dian Rachmawati, and Hari Wahyonono**

Department of Economic Development, Faculty of Economic, Universitas Negeri Malang

**ORCID:**
*Sri Handayani: http://orcid.org/0000-0002-4471-6153*

## Abstract

Learning in the education era 4.0 requires strengthening skills in reaching the golden generation of 2045. According to the STEM Team (2019), there are three core skills of the 21st century, which is the era of education 4.0. These are: 1) character quality consisting of religiosity, nationalism, independence, mutual cooperation and integrity; 2) basic literacy consisting of language, numeracy, scientific, digital, financial and cultural literacy and citizenship; and 3) competencies consisting of critical thinking, creativity, communication and collaboration. To achieve these skills, an appropriate evaluation tool is needed which is tailored to these characteristics. One evaluation model that can be developed is STEM-based evaluation. Rahmatina (2020) states that STEM is learning that integrates science, technology, engineering and mathematics. This study aimed to develop a STEM-based evaluation tool that fits the characteristics of the education era 4.0. Development research methods were used. Borg & Gall (1983: 775) described the stages carried out, namely research and information collecting, planning, developing preliminary forms of the product, preliminary field testing, main product revision, main field testing, operational product revision, and dissemination and implementation.

**Keywords:** STEM, Evaluation Tools, Economic Learning

Corresponding Author:
Sri Handayani
sri.handayani.fe@um.ac.id

Published: 14 July 2021

Publishing services provided by Knowledge E



Selection and Peer-review under the responsibility of the IRCEB Conference Committee.



## 1. Introduction

Learning in the education era 4.0 requires strengthening skills in reaching the golden generation of 2045. According to the STEM Team (2019), there are 3 things that are the skills of the 21st century which is the era of education 4.0, namely 1) character quality consisting of religiosity, nationalism, independence, mutual cooperation, and integrity; 2) basic literacy consisting of language literacy, numeracy literacy, scientific literacy, digital literacy, financial literacy and cultural literacy and citizenship; 3) competencies consisting of critical thinking, creativity, communication and collaboration. Furthermore,

it is said that the national education paradigm in the education era 4.0 is based on 3 things, including: 1) oriented towards science, mathematics and natural sciences along with social and human sciences, 2) education builds scientific attitudes, namely critical, logical, analytical, creative and able to adapt, 3) at every level of education it is necessary to instill a spirit of independence. From this statement, the purpose of education is to prepare students for independence. To design learning activities that are suitable for education 4.0, the learning model is directed to motivate students to find out from various sources of observation. In addition, the learning that is carried out should be directed to be able to formulate problems (ask, not just answer). Therefore, the learning carried out must lead to analytical thinking by emphasizing the importance of cooperation and collaboration in solving a problem.

In an effort to achieve these skills, an appropriate evaluation tool is needed and according to these characteristics. One evaluation model that can be developed is STEM-based evaluation. Rahmatina (2020) states that STEM is learning that integrates science, technology, engineering and mathematics in the learning process. According to Kennedy and Odel (in Keley, 2016), they describe that high quality STEM education must have criteria, namely: 1) integration of technology and engineering into science and mathematics; 2) promote scientific investigation and engineering design, including mathematics and science instruction; 3) a collaborative approach to learning, connecting students and educators with STEM; 4) provide a global perspective and multi perspective; 5) incorporating other strategies such as project-based learning, providing formal and informal learning experiences; 6) incorporate appropriate technology to enhance learning. Because of these various advantages, a lot of research includes STEM elements in learning. As a research conducted by Utami (2017) with the title STEM-A Development (science, technology, engineering, mathematic and animation) Based on Local Wisdom in Physics Learning, the results of the study found that students became aware of the local wisdom of the kuwung stone and how to use it. Another study by Rachmawati (2019) with the title Competence of Economic Teachers in The Industrial Revolution Era 4.0: Case Study at State High Schools in Malang City, Indonesia with research results that the competences of economic teachers are still focused on teaching, gatekeepers, and some facilitators. Then the training model to improve teacher competences in the industrial revolution 4.0 era will be very helpful. In the next study, the development of teacher competency training era in the Republic of Indonesia 4.0 will be carried out with the aim of increasing teacher competence, which in the long run will improve the quality of students. Another research is Handayani (2019) entitled Developing of STEM Based Learning Models for Economic Education Student for Facing

Industry Revolution 4.0 in East Java with the results that 1) STEM-based learning models can be implemented and in accordance with the characteristics of RI 4.0 and 2) This model is effective in increasing the skills of students of economic education in the RI 4.0 era.

Referring to this research, in general, current learning needs to be organized and returned to the identity of learning which essentially prepares students in the education era 4.0. Economic learning in East Java currently still requires changes, especially in terms of the learning process and the use of the learning outcome evaluation format carried out. The essence of learning evaluation actually refers to measuring and assessing the abilities possessed by students in terms of cognitive, psychomotor and affective. This study aims to develop a STEM-based evaluation tool that fits the characteristics of the Education Era 4.0. STEM-based evaluation includes Science assessment, Technology Assessment, Engineering Assessment and Mathematics assessment. To carry out STEM-based assessments, you must test several things in the learning process, namely: 1) checking the quality of STEM learning, 2) measuring student understanding of science and mathematics needed to solve problems, 3) seeing the progress of student teamwork, 4) Assessing the development of STEM skills and 5) examining the attitudes and growth of students' self-confidence.

## 2. Research Methods

The method used in this research is development research. According to Borg & Gall (1983: 775) describes the stages carried out, namely research and information collecting, planning, developing preliminary forms of product, preliminary field testing, main product revision, main field testing, operational product revision, and dissemination and implementation. The subjects used in this study as a validation team consisted of three experts, namely 2 learning evaluation experts and 2 economic learning material experts. The instrument in this study is the validation sheet filled in by the validator. This validation sheet functions to obtain input in the form of criticism, suggestions, and responses to the evaluations developed. The following stages of the research can be explained in Figure 1 below.

The research framework carried out refers to figures 2 and 3 below which contain the object of research as well as the measuring instrument carried out and the technicalities of the research.

The data collection technique in this research is the validation sheet by the validator. To find out the validity of the evaluation tool developed, a validation sheet is given


**Figure** 1: Phases of Developmental Research

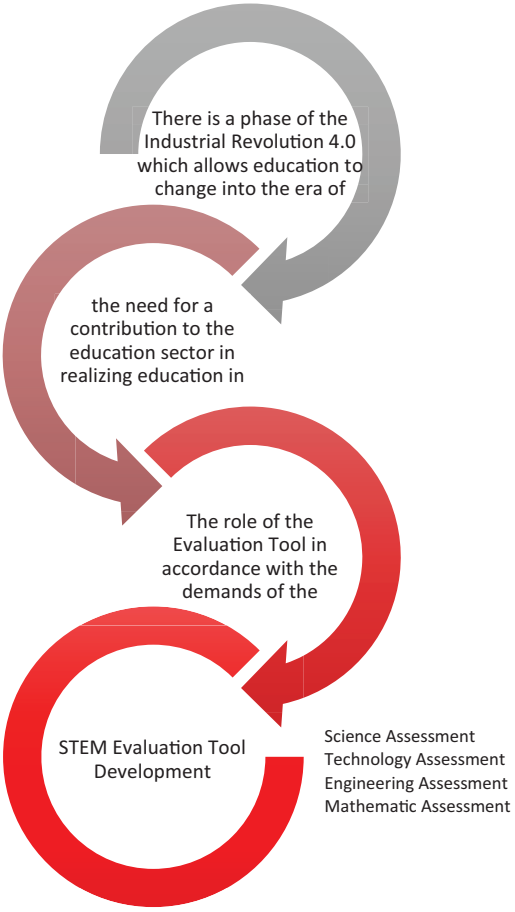


**Figure** 2: Research thinking framework

to the validator and the validator will check the appropriate rows and columns, write revised items if there are deficiencies. The categories in this assessment are invalid (score 1), quite valid (score 2), valid (score 3) and very valid (score 4) (Widoyoko, 2012). In detail can be seen in the review below.

Score 1, if the assessment is very poor / very inappropriate (invalid)

Score 2, if the assessment is not good / not suitable (not valid)

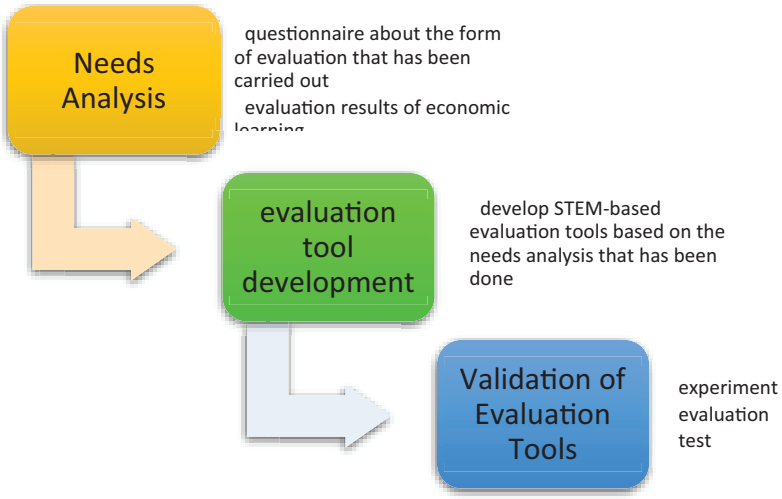


**Figure** 3: Research Design

Score 3, if the assessment is good / appropriate (valid)

Score 4, if the assessment is very good / very appropriate (very valid)

From the score, the average score for each aspect will be calculated using equation 1 below.

$$P\ \% = \frac{S}{N}100$$

**Equation 1. The average score of the validator test**

Where P is the feasibility or product response level, S is the total score obtained by the expert and N is the maximum total score. From equation 2, the STEM-based evaluation tool assessment category is obtained as in Table 1 below.

TABLE 1: Percentage of Feasibility Assessment and User Response

| Percentage of Assessment | Interpretation | User Response Interpretation |
|---|---|---|
| 76 -- 100% | Very Feasible | Very good |
| 50 -- 75% | Feasible | Feasible |
| 26 -- 50% | Sufficient | Sufficient |
| <26% | Less Feasible | Not good |

## 3. Research Results and Discussion

The results of this research obtained can be explained in the description below.

## 3.1. Form of STEM Based Evaluation Tool Development

This development research produced a product in the form of a STEM-based economic learning evaluation tool on the topic of the concept and method of calculating national income, market mechanisms, inflation and consumption, savings and investment. The steps taken in developing this evaluation tool are:

### 3.1.1. Need Analysis

Needs analysis is the first step in this research. Researchers conducted observations of economic learning evaluation tools that have been developed in several state schools in East Java through a google form questionnaire. The results of the google form are used as a basic reference for researchers in developing STEM-based teaching materials. Next, look for literature and reference sources related to the development of STEM-based evaluation tools and also related journals. In addition, they also compile items according to the STEM development procedure.

### 3.1.2. Design

What is done in this stage is the presentation of STEM-based learning evaluation tools. The evaluation tool developed is presented in accordance with the previously prepared Learning implementation design. The evaluation presentation in question contains elements of Science, Technology, Engineering and Mathematics.

### 3.1.3. Development

At this stage, the development of a STEM-based evaluation tool is carried out in accordance with the procedures and demands of the curriculum. What needs to be considered in this stage is the presentation of STEM-based learning evaluation tools. The evaluation tool developed is oriented to the cognitive, attitudes, and psychomotor domains which is carried out using STEM guidelines. Therefore, the developed test instrument must be adapted to the STEM characteristics and material. In this study, developing evaluation tools for the topic of national income, market mechanisms, inflation, and accounting in service companies. Evaluation tools are developed in the form of written tests, performance, and portfolios. After determining the topic and type of instrument, the next step is to draft a STEM-based learning evaluation tool. At this stage

there are changes based on suggestions and input from the validator. The following is the draft component for the development of a STEM-based learning evaluation tool which consists of a cover, foreword, a table of contents, basic concepts of learning evaluation, STEM philosophy, Learning Implementation Plan and STEM-based Economic Learning Evaluation.

## 3.2. Product Feasibility of STEM-Based Learning Evaluation Tool

The feasibility of a STEM-based learning evaluation tool is carried out by validating the product to a validator team consisting of 2 media experts and 2 material experts in the field of economics. Media design experts assess the development of evaluation tools in three ways, namely the size of the learning evaluation tool, the cover design, and the evaluation tool content design. Meanwhile, material experts assessed the development in three aspects, namely the feasibility of content, aspects of presentation, and aspects of language. The data obtained in the form of scores were then converted into four categories, namely Very Feasible, Feasible, Sufficient, Less Feasible. The score obtained is also processed into a percentage for the eligibility criteria. In more detail, see the explanation below.

### 3.2.1. Assessment by media design experts

In detail, the results of the assessment by media design experts can be seen in table 2 and Figure 3 below.

Based on table 2 above, it can be seen that the assessment of the media validator shows that from 3 aspects, namely aspects of paper size, cover design and content design of the evaluation tool, validator 1 gives an assessment of 89.29% and for validator 2 it is 92.86%.

Based on Figure 5, it explains more specifically the 3 aspects assessed by the media validator. Of these three aspects, the highest score of the two validators was the paper size aspect of 93.75%, the lowest aspect was content design at 87.50% and cover design at 91.67.

Overall the assessment of the media expert validator stated that the development of learning evaluation tools already had very feasible criteria. This is in line with Muyassarah's (2019) research which states that the development of an assessment instrument for student motor skills in STEM-based learning is feasible to use. As we know, the

TABLE 2: Media Expert Validator Assessment Results

| Number | Criteria | Expert 1 | Expert 2 |
|---|---|---|---|
| Paper Size Aspects | | | |
| 1 | Matches the paper size used | 4 | 4 |
| 2 | Suitability of paper thickness | 3 | 4 |
| Cover Design | | | |
| 3 | Layout suitability | 4 | 3 |
| 4 | Appropriateness of images and proportions of writing | 3 | 4 |
| 5 | The relationship of the image to the topic | 4 | 4 |
| Content Design Evaluation Tool | | | |
| 6 | The accuracy of the content of the evaluation tool | 3 | 4 |
| 7 | Compliance with evaluation procedures | 4 | 3 |
| **Total Score** | | **25** | **26** |
| **Percentage** | | **89,29** | **92,86** |
| **Information** | | **Very Feasible** | **Very Feasible** |

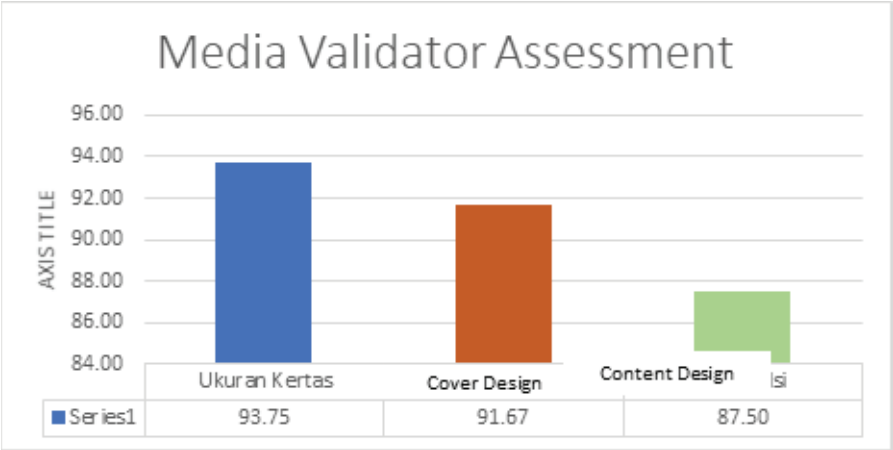


**Figure** 4: The media validator's assessment aspect

development of STEM-based learning evaluation tools has been developed based on 3 aspects and according to the characteristics of STEM.

### 3.2.2. Assessment by material experts

For material expert judgment about developing STEM-based evaluation tools can be seen in Table 3 and Figure 5 below.

In accordance with table 3 it can be seen that the overall assessment of the material experts has stated that it is very feasible. It can be seen that validator 1 gives a total score of 80.56 or 80.56% and validator 2 gives a score of 86.11 or 86.11%. For more detail, each aspect can be explained in Figure 5 below.

TABLE 3: Material expert judgment

| Number | Criteria | Expert 1 | Expert 2 |
|---|---|---|---|
| Content eligibility aspect | | | |
| 1 | Conformity of content with material characteristics | 4 | 4 |
| 2 | Suitability of the selected evaluation tool | 3 | 4 |
| 3 | Procedure accuracy | 3 | 3 |
| 4 | Increase creativity | 4 | 3 |
| 5 | Appropriateness of the evaluation domain | 3 | 3 |
| Presentation aspects | | | |
| 6 | Work order | 3 | 3 |
| 7 | Readability of the procedure | 3 | 4 |
| Linguistic aspect | | | |
| 8 | The suitability of the questions with the learning objectives | 3 | 4 |
| 9 | Language and questions | 3 | 3 |
| **Total Score** | | **29** | **31** |
| **Percentage** | | **80,56** | **86,11** |
| **Information** | | **Sangat Layak** | **Sangat Layak** |

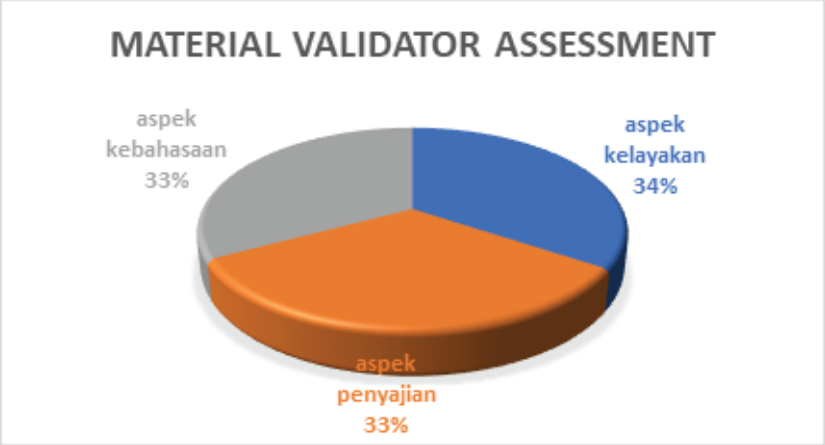


**Figure** 5: Material Validator Assessment Aspects

Based on Figure 5, it can be seen that the highest aspect is the content feasibility aspect, which is 34%. For the linguistic and presentation aspects, the score was 33%.

Overall, from the results of the validation of the expert team, it can be stated that the evaluation tools developed in STEM-based economic learning can be implemented in learning activities. This is because the products developed are in accordance with the STEM characteristics which include Science Assessment, Technology Assessment, Engineering Assessment and Mathematic Assessment. In accordance with the results of research conducted by Aldila (2017) that a validation test has been carried out consisting of a design expert test as well as a material expert test and the product is declared

valid and suitable for use. The test of attractiveness, ease, and benefit was carried out by students and the results of attractiveness were obtained with 3.14, convenience with a score of 3.34 and benefit 3.38. The research design used was a quasi-experimental design in the form of a nonequivalent pre-post control group design. Based on the results of the effectiveness test, it is known that the n-gain value of the experimental class (0.71)> the control class (0.45). It can be concluded that LKPD with the STEM approach has been effective in training students' creative thinking skills.

## 4. Conclusion

From the research results it can be concluded that: (1) development of STEM-based learning evaluation tools with development on aspects of conformity with learning objectives and competencies achieved in learning and material suitability in developing evaluation tools, (2) appropriateness of evaluation tools assessed by experts as in very worthy criteria.

## Acknowledgement

The author would like to express his gratitude to the Head of the Institute for Research and Community Service, State University of Malang (LP2M UM) who gave our team the opportunity to carry out research. Of course also to the research team and to the validators from the media expert team and the material expert team. Do not forget to also all respondents who are willing to help the research team to provide data relevant to this research.

## References

[1] Aldila, C., *et al*.(2017) Pengembangan LKPD Berbasis STEM untuk Menumbuhkan Keterampilan Berpikir Kreatif Siswa. *Jurnal Pembelajaran Fisika*, vol. 5, issue 4, pp. 85-95.

[2] Handayani, S., *et al*. (2020). Developing of STEM Based Learning Models for Economic Education Student for Facing Industry Revolution 4.0 in East Java. Presented at *CORECT-IJJSS 2019*. February,2020. China:e3s-conferences

[3] Kelley, T. R., *et al*. (2016). A Conceptual Framework for Integrated STEM Education. *International Journal of STEM Education*, 3(1),pp. 1 - 11.

[4] Muyassarah, A. (2019). Pengembangan Instrumen Penilaian Kemampuan Motorik Siswa pada Pembelajaran Berbasis STEM (Science, Technology, Engineering and Mathematic) untuk Materi Energi Kinetik. Yogyakarta: Respository Universitas Ahmad Dahlan, pp 1-10.

[5] Rachmawati, D., *et al*. (2020). Competence of Economic Teachers in the Industrial Revolution Era 4.0: Case Study at State High Schools in Malang City, Indonesia. Presented at *International Conference on Economics, Business and Economic Education 2019*, pp. 1286 – 1290. March, Jakarta, Indonesia: KnE Publishing

[6] Rahmatina. (2020). Pengembangan Bahan Ajar Berbasis Science, Technology, Engineering, and Mathematics (STEM) di SMA/MA. *Jurnal Phi: Jurnal Pendidikan Fisika dan Fisika Terapan*, vol. 1, issue 1, pp. 27-33.

[7] Tim STEM. (2019). Pendidikan Abad 21 & Filosofi STEM. *Jakarta: Kementrian Pendidikan dan Kebudayan*.

[8] Utami, I. S., *et al*. (2017). Pengembangan STEM-A (*Science, Technology, Engineering, Mathematic And Animation*) Berbasis Kearifan Lokal Dalam Pembelajaran Fisika. *Jurnal Ilmiah Pendidikan Fisika Al-BiRuNi*, vol. 6, issue 1, pp. 67-73.

[9] Widoyoko, E. P. (2012). *Teknik Penyusunan Instrumen Penelitian*. Yogyakarta: Pustaka Belajar.