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Evaluation of the system "quality of education" and its socio-economic impact: analogies with software testing

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Abstract. The article is devoted to creating a reliable algorithm for testing the quality of the education system, determining the system's relationship with the goals of sustainable development, and the resolution of indicators of the socio-economic impact of the system. The substantiation of the application of analogies between testing software products and testing the dynamic system "quality of education" is presented. A type of relationship between the goal of sustainable development SDG 4 "Quality education" and other goals of sustainable development, particularly with SDG 8, "Decent work and economic growth" through the criteria for evaluating educational programs, is proposed. Based on the bibliometric analysis, the indicators of the socio-economic impact of the "quality of education" system are highlighted. The general algorithm for testing the design and the structural and logical diagram of the relationship between internal and external testing of the system are presented.

Keywords: quality of education, education policy, testing, socio-economic impact

1. Introduction

The dynamic system of "quality of education" has a decisive influence on forming a new academic culture, which is designed to ensure the competitiveness of graduates in the labor market. Testing this system is essential in assessing its performance (including socio-economic impact at the regional, national, and international levels). During testing, the performance of each node and the system as a whole is assessed. It allows you to identify errors (bugs) in the system and propose measures to eliminate them. In addition, it is necessary to consider

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the system of "quality of education" as an element of the strategy for ensuring sustainable development (sustainable development goals) and determine the relationship between individual goals of sustainable development.

The purpose of this work is to create a reliable algorithm for testing the system "quality of education", determine the relationship of the system with the goals of sustainable development, and determine indicators of the socio-economic impact of the system.

2. Literature review

The "quality of education" system is developing dynamically while ensuring proper internal and external conditions. Many literary sources [19, 22, 23, 27, 29, 30] form the requirements for the successful functioning of quality assurance systems. These conditions can be the basis for the formation of indicators of the socio-economic assessment of the quality of education. The variety of these indicators allows their combination to achieve tactically (quality of education and quality of scientific activity) and strategic (socio-economic development resulting from an effective quality system) goals. It is also of interest to increase the socio-economic efficiency of the "quality of education" system by drawing analogies with the processes of testing software products [6], describing physical functions [1], using tools for assessing causal relationships [2, 3, 14, 17, 26]. An essential stage in the formation of a quality education system is to ensure the relationship between SDG 4 "Quality education" and other goals of sustainable development [4, 8, 9, 18, 24, 34, 36, 37], especially with SDG 8 "Decent work and economic growth". Such an integrated approach made it possible to see the prospects for the development of both the quality assurance system as a whole (using the examples of universities) and individual educational programs [5, 10, 11, 16, 21, 28].

3. Research methodology

This paper proposes using the analogy between software testing and testing the effectiveness of a quality assurance system at a university. The general algorithm for the formation of the educational structure and assessment of its quality can be represented in the form of a logical scheme "creation" – "analysis" – "implementation" (figure 1).

The choice of parameters for testing the system "quality of education" is carried out in accordance with the main keywords obtained on the basis of bibliometric analysis of 2000 most cited articles in journals, which are indexed by the scientometric database Scopus (publication period 2015-2020, analysis tool – VOSviewer) upon request "testing of education". The results of the bibliometric analysis are presented in figure 2. Analysis of keywords shows that the socio-economic component (the keywords "socioeconomic status", "economic growth", "job satisfaction", "human capital", etc.) occupies an important place in the design of the system of "quality of education".

In addition, an important keyword that appears in the search results is "sustainable development". The presence of this keyword and understanding the importance of sustainable development goals in the formation of the relationship between the quality of education and economic growth require the creation of a diagram of the relationship between these parameters.

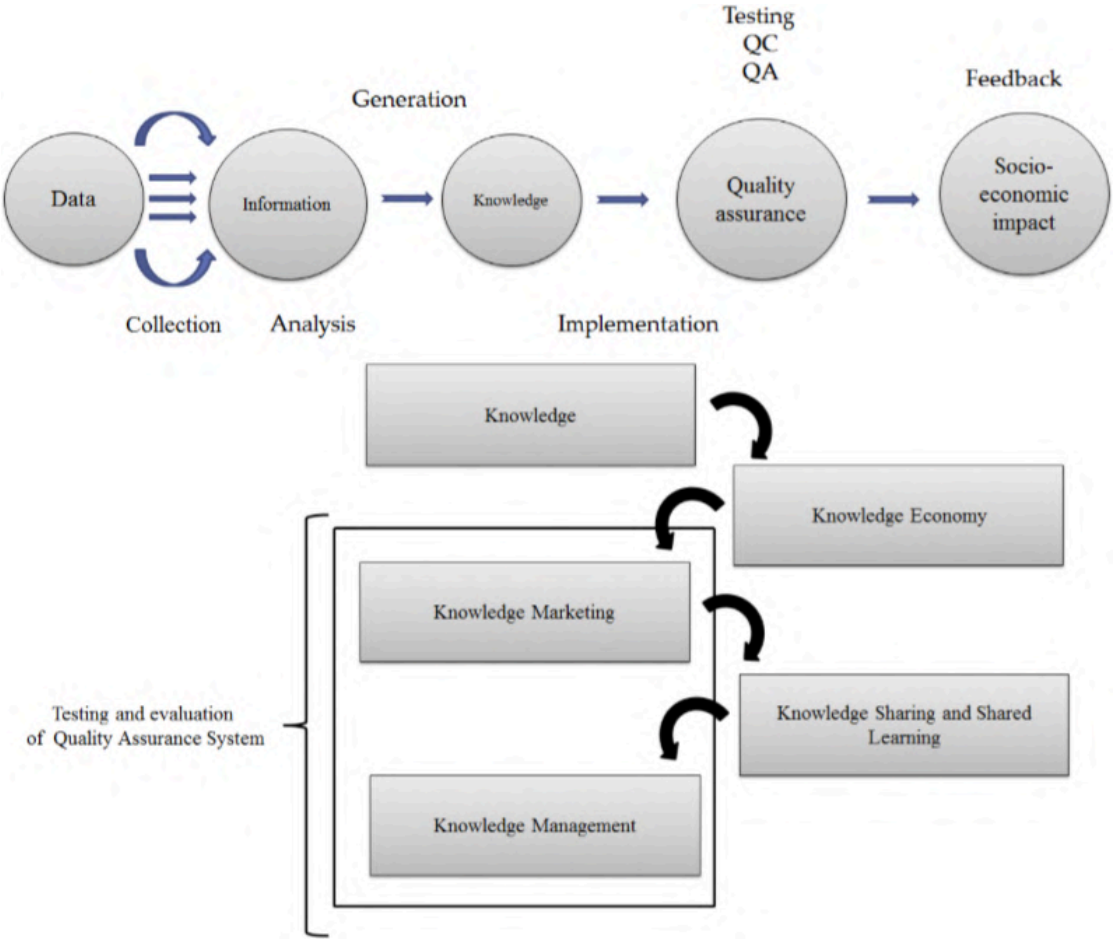


Figure 1: Formation of the educational structure and its testing.

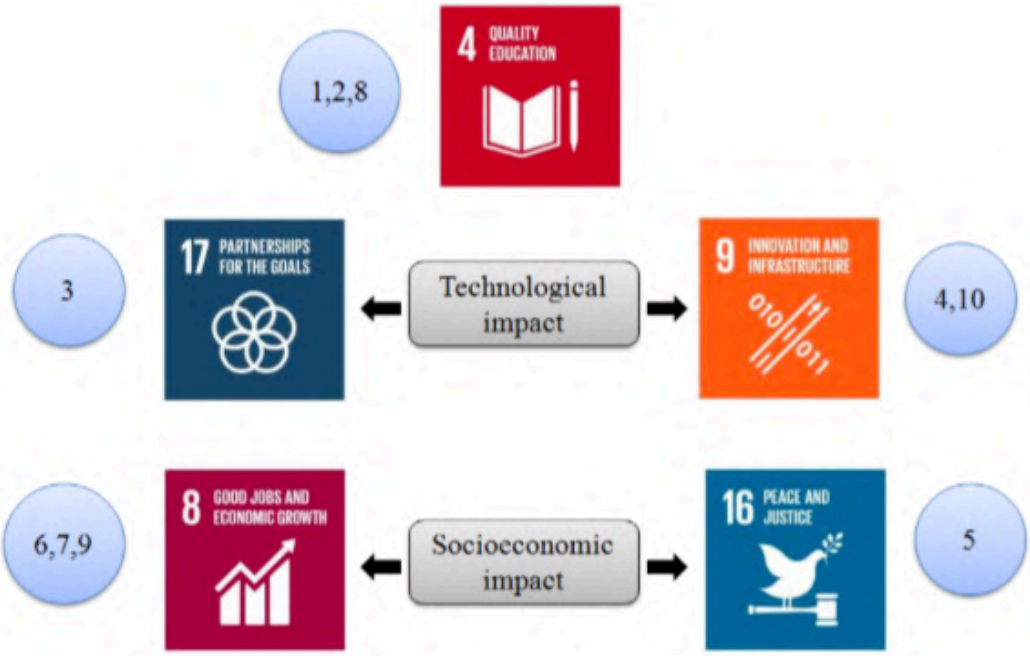
The structural and logical diagram of the relationship between SDG 4 and other sustainable development goals is shown in figure 3.

4. Testing the "quality of education" system and determining its socio-economic impact

Testing of the "quality of education" model is carried out from within and from the outside (figure 4). This process is described in detail in [35]. The first (internal) stage of testing is to check the performance of the quality system by the forces of its creators. Optimization calculation of the trajectory, the introduction of the "quality of education" system and its testing is carried out after the creation of a functioning model. The model is based on the regulatory framework, which at the system level describes the role of each participant (department) in the formation of the quality system, algorithms of actions in various aspects of the formation of the system, etc. The effectiveness of the regulatory framework and algorithms should be

Figure 2: Bibliometric analysis on the request “testing of education”, keywords for determining the indicators of testing the system “quality of education.

confirmed by testing both individual blocks of the system (quality in educational and scientific activities, student surveys, the effectiveness of the quality assurance center, ensuring a plan for implementing the decisions of the quality council, etc.), and the system as a whole (blocks testing and overall model testing). At this stage, errors (bugs) in the operation of system elements as stand-alone components are identified. So it is in conjunction with other components. After preliminary testing (quality control), an overall assessment of the applicability and performance of the model is made. At this stage, close attention is paid to the “interface” of the system, which provides the convenience of introducing the elements of the quality system to an individual user – a participant in educational and / or scientific processes at the university. This stage (quality assurance) is decisive and only after a positive answer to the question “have all the tasks been achieved during the operation of the model?” the system can be tested externally.



Criterion 1. Design and objectives of the educational program.
Criterion 2. The structure and content of the educational program.
Criterion 3. Access to the educational program and recognition of learning outcomes.
Criterion 4. Teaching and learning in the educational program.
Criterion 5. Control measures, evaluation of higher education seekers and academic integrity.
Criterion 6. Human resources.
Criterion 7. Educational environment and material resources.
Criterion 8. Internal quality assurance of the educational program.
Criterion 9. Transparency and publicity.
Criterion 10. Learning through research.

Figure 3: The relationship between the goals of sustainable development and the provision of quality criteria for educational programs.

Testing from the outside is done in two parallel ways.

1. Accreditation from independent education quality assurance agencies. The criteria for assessing the quality of the educational program and the quality system as a whole are shown in figure 3. Based on the results of accreditation, the following decisions can be made:
    - full compliance of the educational program and quality system with elements criteria with of innovation;
    - full compliance of the educational program and quality system with criteria elements with minor remarks;

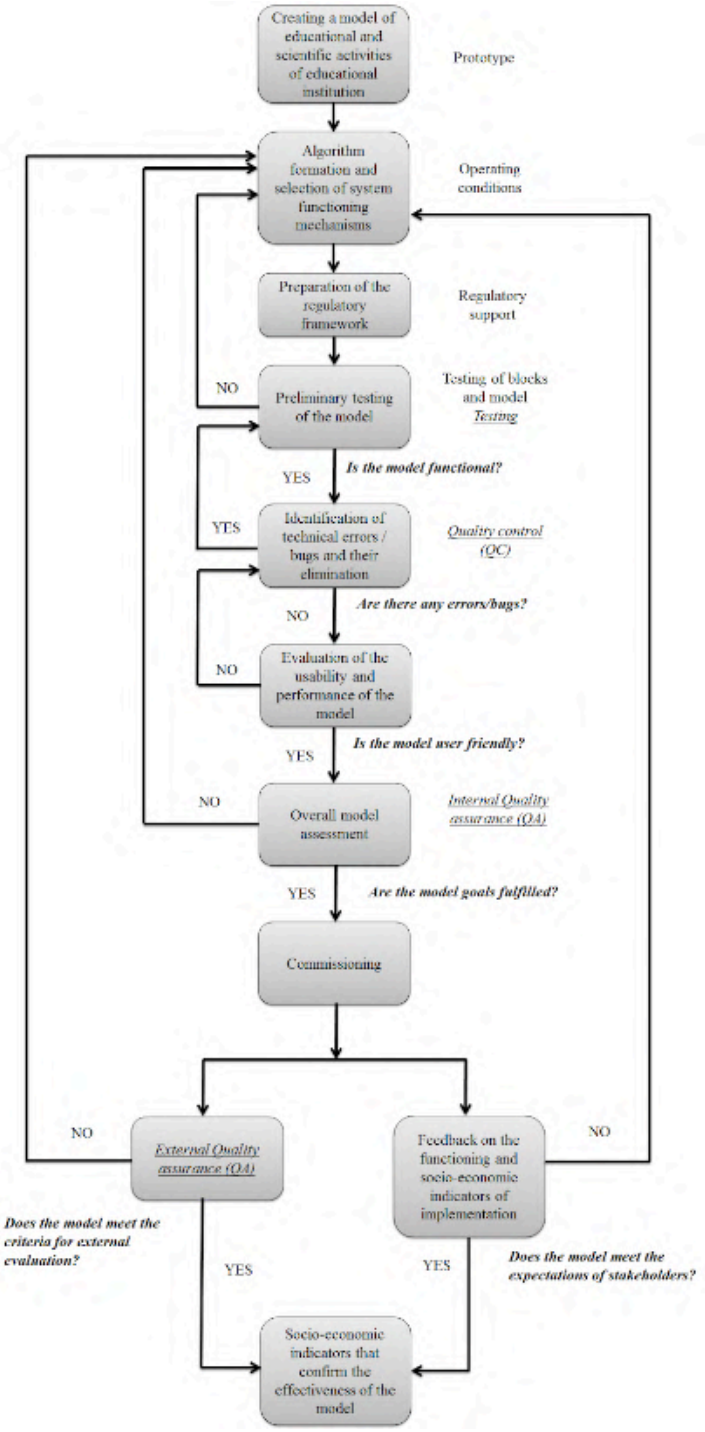


Figure 4: Testing the model "quality of education" and determining the socio-economic impact of the system [35].

- critical discrepancy between the educational program and the quality system according to one or more criteria;
- critical discrepancy between the educational program and the quality system by most criteria.

To eliminate critical remarks, the university is given a certain period of time, during which there is a return to the internal stage of testing with the stages described above.

2. Evaluation of external stakeholders and rating agencies. Here the main attention is paid not only to the indicators of the quality of educational / scientific activities, but also to the socio-economic consequences of the introduction of an effective quality system at the university.

For example, the British publication Times Higher Education in April 2021 published the third issue of THE University Impact Rankings, which aims to analyze the impact of higher education on society and the achievement of UN goals in the field of sustainable development [7, 12, 13, 15, 32, 33]. The ranking takes into account the achievements of universities in achieving each of the 17 goals, and also forms an overall list of University Impact Rankings. In addition to the general place in the world ranking, places are determined for each of the sustainable development goals. Another example of attracting universities to address sustainable development issues through appropriate actions in their scientific, educational and production activities is the UI GreenMetric rating [31]. Among the examples of assessing external stakeholders, the DOU rating of IT graduates should be highlighted [25].

The results of the assessment by external stakeholders and rating agencies are the basis for returning to internal testing of the model, identifying its weaknesses and ways to improve.

As a continuation of work [35], the algorithm was tested by the external stakeholders. Testing was carried out based on accreditation examinations of educational programs by the National Agency for Higher Education Quality Assurance (NAQA) [20] (figure 5).

External quality assessment was carried out according to the following criteria (as mentioned on figure 3):

Criterion 1. The design and objectives of the study program.
Criterion 2. The structure and content of the study program.
Criterion 3. Access to the study program and learning outcomes recognition.
Criterion 4. Teaching and learning under the study program.
Criterion 5. Control measures, evaluation of students and academic integrity
Criterion 6. Human resources.
Criterion 7. Educational environment and material resources.
Criterion 8. Internal quality assurance of the study program.
Criterion 9. Transparency and publicity.
Criterion 10. Study through research (applied during accreditation of study programs of the third cycle of higher education.

Level A – the study program and/or the educational activity under such program fully meet the defined criterion and are of an innovative/exemplary character.

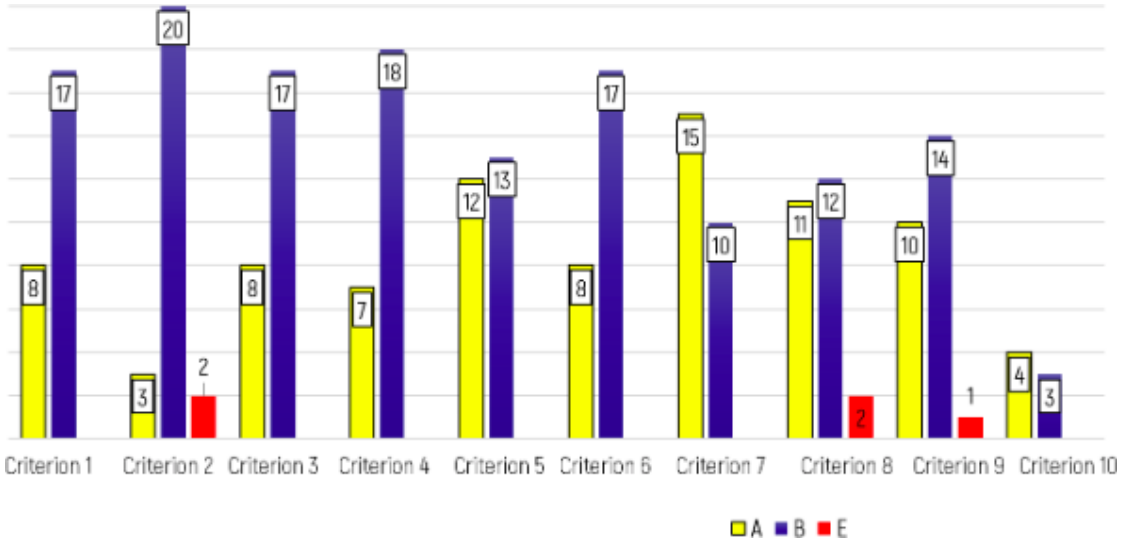


Figure 5: Results of external accreditation (examination) of the Sumy State University educational programs conducted by the (NAQA).

Level B – the study program and/or the educational activity under such program meet the defined criterion in general, with possible shortcomings that are deemed minor.

Level E – the study program and/or educational activities under such program do not meet the defined criterion in general but identified shortcomings can be eliminated within a one-year period.

The results of accreditation, together with the data of rating agencies, were considered when improving the rating of structural units of Sumy State University. Separately, it should be noted that, based on accreditation results, decisions were made to organize the process of introducing innovative teaching methods, strengthening human resources, improving the university regulatory framework, etc. Decisions allow you to influence the marked increase for each of the ten criteria for evaluating the educational program.

5. Conclusions

The proposed testing algorithm for the dynamic system "quality of education" allows to conduct a two-stage performance check and highlight the possible loss of connections (the appearance of bugs) between the elements of the system. The approach described in the article to assessing the effectiveness of the functioning of the model through internal and external testing (including through the assessment of the socio-economic impact of the system) makes it possible to determine the key indicators of the quality assurance system management. Based on this testing, mechanisms are being developed to enhance the socio-economic impact of the "quality of education" system at the university, regional, national, and international levels.

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