Development of the model of external control of quality indicators of electronic courses

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Abstract. This article presents an analytical survey of internationally accepted samples for the assessment of online courses. By reviewing existing practices from around the world, the article identifies common approaches and methodologies used to evaluate the quality of electronic courses. This approach utilizes a combination of simple numeric values and fuzzy linguistic variables, which are then aggregated using fuzzy logic. This combination of numeric values and linguistic variables allows for a more comprehensive assessment of electronic courses. It takes into account both quantifiable factors, such as completion rates or assessment scores, as well as subjective factors, such as user satisfaction or engagement levels by utilizing fuzzy logic, the proposed approach is able to handle the inherent uncertainty and subjectivity in some of these indicators. The proposed approach aims to provide a more robust and accurate evaluation of the quality of electronic courses. It builds upon internationally accepted samples and incorporates a combination of objective and subjective indicators, using fuzzy logic to handle the varying degrees of uncertainty. This approach can contribute to the development of a standardized and comprehensive system for assessing the quality of electronic courses.

1 Introduction

According to contemporary global trend, there are technologies of electronic learning (e-learning) widely adopted in the Russian educational system and applied on academic, inter-academic, regional and corporate levels. With each passing day, e-learning has the greater impact, and one of the most popular and prevailing type of e-learning is massive open online courses (MOOC).

However, the credibility problem of e-learning's results is very urgent. Discussions regarding online education increasingly touch the mechanism of assessment and control of

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the quality of academic activity within the frameworks of the e-learning, as well as the training of experts in accordance with new requirements of the Russian legislative norms.

Nowadays in Russia, a number of initiatives aimed at creation of conditions necessary for the development of the digital economy, is being implemented resulting in increasing of the marketability and citizens' quality of living and attaining economic growth and national sovereignty. First of all, it is "The strategy of the development of the information society of the Russian Federation for 2017-2030" and "The digital economy of the Russian Federation" programme [1]. The implementation of the priority educational project "The modern digital educational environment in the Russian Federation" provides for a number of lines including a foremost one – the formation of the expert and user quality control system of the content of online courses.

2 Results and discussion

By adopting internationally accepted samples, the Russian Federation can ensure that the content of electronic courses is organized in a clear and effective manner. Additionally, the use of well-proven models for quality assessment can help to verify the knowledge received by students.

By implementing a system of quality assessment for online courses, the Russian Federation can ensure that students are receiving high-quality education and that their knowledge is being effectively evaluated. This can contribute to the overall improvement and development of online education in the country [2, 3].

In conclusion, the absence of norms regulating the organization and verification of electronic course content in the Russian Federation highlights the need for a system of quality assessment. By adopting internationally accepted samples and models for assessment, the country can ensure that online courses are efficient and meet established standards.

Systems focused on the quality control of the e-learning have been successfully developed worldwide for last several years [4].

The European Network for Quality Assurance in Higher Education (ENQA) has developed "Standards and recommendations for quality assurance in the European Higher Education Area (ESG), which contain basic requirements to the quality system of educational institutions, including those pertaining to the quality assessment of the e-learning [5].

The European Foundation for Quality in e-Learning (EFQUEL), for the purpose of forming the quality assurance of the e-learning, implements two international certification projects: the UNIQUe and the ECB CHECK. The programme "Guaranteeing the quality of e-learning in European universities (the UNIQUe)" is aimed at certification works on the institutional level; separate faculties can also be assessed [6]. As compared to the UNIQUe, the ECB CHECK projects provides for certification of separate educational programmes [7].

In US, the National standard of assessment of online courses called Quality matters (QM) is widely used. QM is focused on the assessment of separate programmes/courses and the attraction of faculty experts as well as systematization of ratings for assessment of educational online courses. QM's rating consist of 40 special criteria grouped into 8 general standards including the following: general characteristic of the course; learning goals; evaluations and measurements; resources and materials; involvement of students into the academic activity; technologies of the course; students' support; availability [8].

The offered approaches to the quality assessment of e-learning may be adopted for using in Russia, particularly for evaluation of Russian electronic courses. In this context, the specificity of the Russian educational system and local standards justified with foundational international standards should be taken into account.

In a loose sense, the assessment of online courses can be viewed as two independent "streams" [1]: the mandatary evaluation of the online course (the external control for

compliance with formal requirements), being the scope of research of this article, and the continuous evaluation made by users of the course which has been already placed into the system of distant teaching (SDT) in the electronic information educational environment (EIEE) of a particular academic institution (Figure 1).

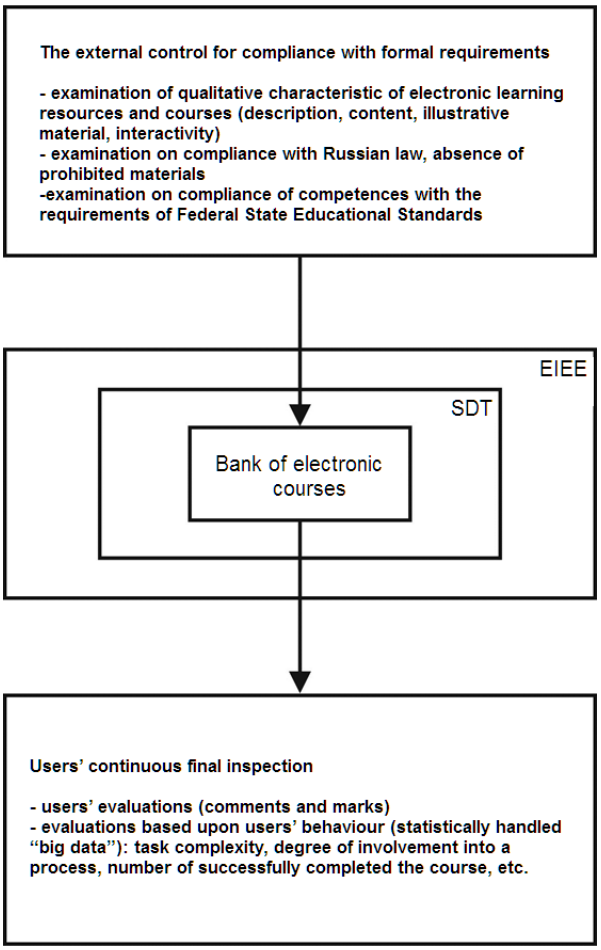

Fig. 1. The general assessment model of online courses.

The hierarchical concept of organizing a family of quality indices is a common approach used in the evaluation of electronic courses. This methodology involves creating a hierarchy of indices, with the top index representing the overall quality of the course and lower-level indices representing specific aspects of the course.

It is important to note that online courses are often subject to constant change and adaptation, which means that the structure and content may not have a "final" version. Therefore, any assessment procedure should consider both quantitative and qualitative indices to comprehensively evaluate the course [9].

The assessment process may involve the use of a contraction function, which combines multiple indices into a single figure. This helps to provide an overall assessment of the course's quality. By incorporating this hierarchical methodology and forming an assessment council, the Russian Federation can establish a robust system of quality assessment for electronic courses. This will contribute to the improvement and standardization of online education in the country.

A simple qualimetric approach to the quality assessment should consist of the following steps:

1. To identify indicators (indices, criteria) affecting quality.
2. The indicators to be quantitatively evaluated by experts.
3. Each indicator to receive a weighting coefficient.
4. The final results can be represented by a single figure, a convolution function of indices' values; for instance, it can be the sum of indicators multiplied by their weighting coefficients.

The proposed approach in this article acknowledges the potential danger of extreme approaches in formalizing the criteria for evaluating electronic courses. On one hand, there is a risk of representing initially vague and subjective criteria with conventional precise values. On the other hand, there is also a risk of transforming all input indicators, including those that can be precisely quantified, into fuzzy linguistic variables (LV).

By using precise values for factors that can be objectively quantified, such as the number of course materials, average completion time, or student satisfaction ratings, a more accurate and quantitative assessment can be achieved.

At the same time, fuzzy linguistic variables (LV) are used for factors that are inherently vague and subjective, such as the quality of course content, level of interactivity, or instructor engagement. Fuzzy logic allows for the representation and manipulation of such linguistic variables, capturing the inherent uncertainty and subjectivity in these factors.

By combining both precise values and fuzzy linguistic variables, the proposed approach aims to strike a balance between objectivity and subjectivity in the evaluation of electronic courses. This allows for a more comprehensive and nuanced assessment that takes into account both quantifiable aspects and subjective factors.

The article emphasizes the importance of carefully categorizing and handling input factors to avoid the extremes of oversimplification or overcomplication. Ultimately, this approach aims to provide a more robust and accurate evaluation of the quality of electronic courses.

For handling of qualitative indicators, it is seen efficient to use methods of fuzzy logic [10-11]. Introducing the "fuzzy set" term is an attempt to formalize the linguistic information aiming at creation of mathematical models. The term is based upon an idea that the elements of a set, being carriers of a general property, possess said property to a different extent consequently they belong to the set to a different extent.

It is commonly known that fundamentals of fuzzy logic contain "fuzzy set" and "linguistic variable" terms. The fuzzy set is characterized by a continuous membership function, which can possess any medium value between 0 and 1. The linguistic variable stands for a variable, which is defined on the linguistic scale and possesses values in the form of words and phrases of the natural language. An individual value of LV (or the linguistic value, the term) is assigned with the help of membership function only, i.e. each term is consonant to a fuzzy set.

All indicators are considered equivalent in their importance. To calculate the aggregate value of convolution, a simple sum is used, ranging from 0 to 21. This means that the total score for the course can range from 0 to 21, with higher scores indicating better quality. Using a structured and objective assessment method allows for a clear and standardized evaluation of electronic courses. By assigning numerical values to different indicators and summing them up, the overall quality of the course can be quantitatively measured. This approach provides a quantitative and objective basis for evaluating the quality of electronic courses. It can be used to compare and rank different courses, identify strengths and weaknesses, and provide feedback for improvement. This can ensure consistency and accuracy in the assessment of electronic courses. Overall, this approach provides a practical and systematic

way to assess the quality of electronic courses based on a set of structured indicators and a straightforward aggregation method.

The tool of fuzzy output algorithm for building of the model of external control of electronic courses is supposed to be Matlab system with the built-in Fuzzy Logic Toolbox packet, the basic term of which is FIS-structure – a Fuzzy Inference System, which contains all necessary data in order "inputs-outputs" robust transform to be implemented.

In accordance with the above listed classification, we have three input LV: "The convolution of numeric criteria" ('convolution'), "The scientific character and innovation level of the presented educational and methodological material" ('science'), "The visibility and availability of the material" ('design') and one output LV: "The evaluation of the quality of the course" ('quality') (Figure 2).

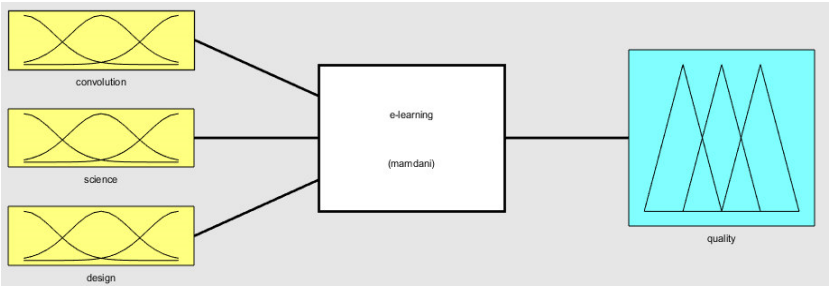

Fig. 2. The model of external quality control of online courses on the basis of fuzzy logic.

The membership functions of levels of input and output LV were made in Matlab and presented by Figures 3-6.

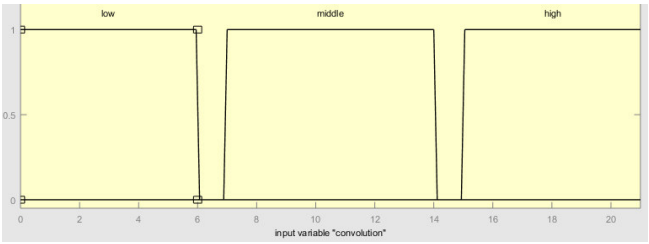

Fig. 3. The membership function of "The convolution of numeric criteria" input variable.

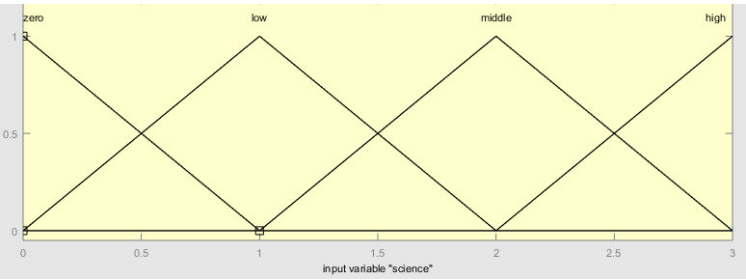

Fig. 4. The membership function of "The scientific character and innovation level of the presented educational and methodological material" input variable.

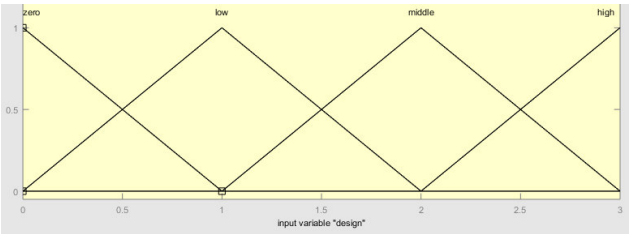

Fig. 5. The membership function of "The visibility and availability of the material" input variable.

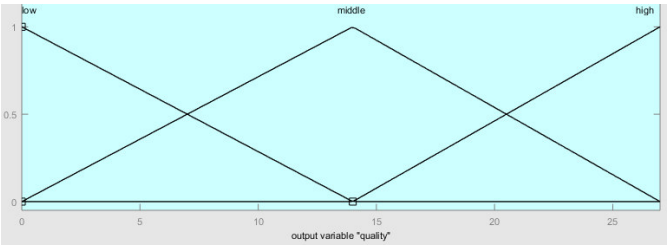

Fig. 6. The membership function of "The evaluation of the quality of the course" output variable.

The complete rule database is drawn by Figure 7.

1. If (convolution is low) and (science is zero) and (design is zero) then (quality is low) (1)
2. If (convolution is low) and (science is zero) and (design is low) then (quality is low) (1)
3. If (convolution is low) and (science is zero) and (design is middle) then (quality is low) (1)
4. If (convolution is low) and (science is zero) and (design is high) then (quality is low) (1)
5. If (convolution is low) and (science is low) and (design is zero) then (quality is low) (1)
6. If (convolution is low) and (science is low) and (design is low) then (quality is low) (1)
7. If (convolution is low) and (science is low) and (design is middle) then (quality is low) (1)
8. If (convolution is low) and (science is low) and (design is high) then (quality is low) (1)
9. If (convolution is low) and (science is middle) and (design is zero) then (quality is low) (1)
10. If (convolution is low) and (science is middle) and (design is low) then (quality is low) (1)
11. If (convolution is low) and (science is middle) and (design is middle) then (quality is low) (1)
12. If (convolution is low) and (science is middle) and (design is high) then (quality is low) (1)
13. If (convolution is low) and (science is high) and (design is zero) then (quality is low) (1)
14. If (convolution is low) and (science is high) and (design is low) then (quality is low) (1)
15. If (convolution is low) and (science is high) and (design is middle) then (quality is low) (1)
16. If (convolution is low) and (science is high) and (design is high) then (quality is low) (1)
17. If (convolution is middle) and (science is zero) and (design is zero) then (quality is low) (1)
18. If (convolution is middle) and (science is zero) and (design is low) then (quality is low) (1)
19. If (convolution is middle) and (science is zero) and (design is middle) then (quality is middle) (1)
20. If (convolution is middle) and (science is zero) and (design is high) then (quality is middle) (1)
21. If (convolution is middle) and (science is low) and (design is zero) then (quality is low) (1)
22. If (convolution is middle) and (science is low) and (design is low) then (quality is low) (1)
23. If (convolution is middle) and (science is low) and (design is middle) then (quality is middle) (1)

24. If (convolution is middle) and (science is low) and (design is high) then (quality is middle) (1)
25. If (convolution is middle) and (science is middle) and (design is zero) then (quality is low) (1)
26. If (convolution is middle) and (science is middle) and (design is low) then (quality is middle) (1)
27. If (convolution is middle) and (science is middle) and (design is middle) then (quality is middle) (1)
28. If (convolution is middle) and (science is middle) and (design is high) then (quality is middle) (1)
29. If (convolution is middle) and (science is high) and (design is zero) then (quality is low) (1)
30. If (convolution is middle) and (science is high) and (design is low) then (quality is middle) (1)
31. If (convolution is middle) and (science is high) and (design is middle) then (quality is middle) (1)
32. If (convolution is middle) and (science is high) and (design is high) then (quality is middle) (1)
33. If (convolution is high) and (science is zero) and (design is zero) then (quality is low) (1)
34. If (convolution is high) and (science is zero) and (design is low) then (quality is low) (1)
35. If (convolution is high) and (science is zero) and (design is middle) then (quality is low) (1)
36. If (convolution is high) and (science is zero) and (design is high) then (quality is low) (1)
37. If (convolution is high) and (science is low) and (design is zero) then (quality is low) (1)
38. If (convolution is high) and (science is low) and (design is low) then (quality is middle) (1)
39. If (convolution is high) and (science is low) and (design is middle) then (quality is middle) (1)
40. If (convolution is high) and (science is low) and (design is high) then (quality is middle) (1)
41. If (convolution is high) and (science is middle) and (design is zero) then (quality is low) (1)
42. If (convolution is high) and (science is middle) and (design is low) then (quality is middle) (1)
43. If (convolution is high) and (science is middle) and (design is middle) then (quality is middle) (1)
44. If (convolution is high) and (science is middle) and (design is high) then (quality is high) (1)
45. If (convolution is high) and (science is high) and (design is zero) then (quality is low) (1)
46. If (convolution is high) and (science is high) and (design is low) then (quality is middle) (1)
47. If (convolution is high) and (science is high) and (design is middle) then (quality is high) (1)
48. If (convolution is high) and (science is high) and (design is high) then (quality is high) (1)

Fig. 7. The rule data base.

With the help of FIS Editor, let us draw out "input-out" surfaces, which correspond to the fuzzy system being composed (Figure 8).

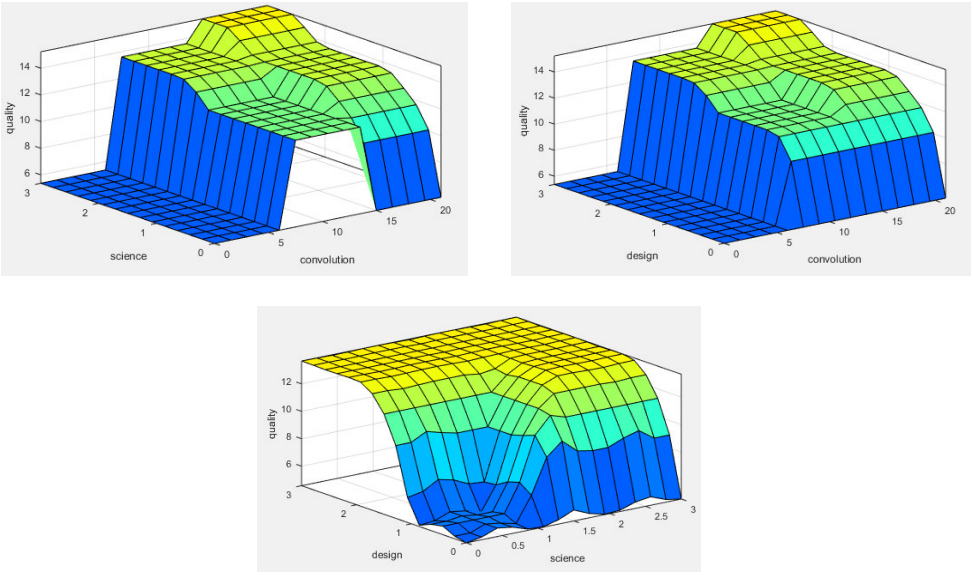

Fig. 8. Dependence of the output variable "Course quality assessment" on input variables.

The testing of the constructed model lies in the assigning values to input variables in "Rule Viewer" window (Figure 9). Thus, the desired result is calculated by the programme through defuzzification procedure. Obviously, that having handled the final evaluation of the quantitative indicators equals 12 (slightly above average) and in view of the fact that the presented material is up-to-date and corresponds to the scientific and technological level in the sub discipline under consideration plus the Materials of the course are given in a language known to the target audience, but not illustrated enough; the main points are not clearly

identified, the course is evaluated as middle and may be recommended for placement in SDT of EIEE of a particular academic institution, but not for the submission in MOOC.

3 Conclusion

This article proposes an approach for constructing a system of quality indicators for electronic courses using a combination of simple numeric values and fuzzy linguistic variables. The approach involves developing a control model based on fuzzy logic to evaluate these indicators. The model has been built and tested for several indicators, but further development is needed. Future development should focus on increasing the number of factors considered in the assessment, gathering statistical and expert information to define the membership functions of linguistic variables, and creating a rule database that connects input and output variables in the assessment model. These enhancements will allow for a more comprehensive and accurate evaluation of the quality of electronic courses. By incorporating fuzzy logic and a combination of numeric and linguistic variables, the proposed approach can provide a more nuanced and flexible assessment of electronic courses. This can contribute to the development of a robust and comprehensive system of quality evaluation that takes into account the dynamic nature of online education.

Fig. 9. The testing of the model built.

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