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UTILIZING COMPUTER-BASED CONTENT ANALYSIS METHODS FOR ENHANCING CRITICAL THINKING IN STUDENTS

ABSTRACT

Formulation of the problem. *The Article Addresses the Issue of Cultivating Critical Thinking in Students Through Document Content Analysis. Description of a Pedagogical Experiment on the Integration of Sociology and Computer Science for students, with the Aim of Mastering Computer-Based Content Analysis Methods for Sociological Research.*

Materials and Methods. *Theoretical Research Methods: We conducted an analysis and synthesis of scientific sources to uncover the fundamental principles related to the research problem. Empirical Research Methods: We utilized various empirical techniques such as surveys, observations, and interviews. Statistical Methods for Processing Respondent Data: We employed statistical approaches to process and analyze the results of the surveys conducted with the respondents.*

Results. *The effectiveness of the experiment is evident from the results of the repeated control assessment, particularly the positive trend in average scores within the EG group compared to the CG at the end of the experiment. There is a noticeable increase in scores across various evaluation criteria, such as the utilization of a diverse range of tools for substantiation, logical consistency in thought, the presence of well-grounded conclusions, and an attempt at an accurate forecast of social phenomena*

Conclusions. *The proposed algorithm for implementing interdisciplinary connections between computer science and sociology through the use of computer-based content analysis methods holds significant importance. It fosters critical and algorithmic thinking in students, enhances their information technology competency, and nurtures their ability to assess properties of information flows and understand the nature of information conflicts.*

KEYWORDS: *Critical thinking, Content analysis, computer-based content analysis methods, text data analysis, students.*

INTRODUCTION

Formulation of the problem. In modern education, the task of developing critical thinking skills is of paramount importance due to the vast amounts of information that require the ability to analyze and draw sound conclusions. In this context, computer science serves as an auxiliary resource, providing a foundation for demonstrating technical methods for rapid message analysis. Over millennia, human civilization has accumulated and continues to amass vast amounts of information, primarily in the form of textual data. These data are prevalent in all scientific fields, including sociology.

Leveraging powerful information mechanisms for search, analysis, synthesis, and comparison makes it possible to achieve the primary goal of sociology – gaining an understanding of objective reality, elucidating and forming conscious perceptions of society, its developmental patterns, and interactions.

The technological and technical capabilities of text data analysis necessitate professionals who can think critically and possess information technology competence. Students' ability to work with statistical analysis programs and text data analysis software will enable them to use information about society not just as a chaotic stream but to analyze, interpret it, and draw corresponding conclusions. Proficiency in content analysis methods will contribute to their capacity to assess the properties of information flows, understand the nature of information warfare, and develop critical and algorithmic thinking.

Therefore, fostering critical thinking is pertinent when employing computer-based content analysis methods. It significantly enhances the evaluation and analysis of economic, political, behavioral, and other issues.

Analysis of current research. The ability to think critically and methods for developing critical thinking skills are of interest to researchers in various fields. This skill is important in various areas of life, including education, professional activities, problem-solving, decision-making, and critically assessing information from the media. O. Pometyun defines critical thinking as the process of actively, systematically, and objectively analyzing and evaluating information, ideas, situations, or problems in

order to make informed and reasoned decisions. It involves the ability to analyze information critically, understand the context, and assess the validity of arguments (Pometyun, 2018). The key components of critical thinking, boundary approaches, and ways of development were explored by N. Kozachenko (Kozachenko, 2017), including analysis, evaluation, synthesis, and critical understanding of the context.

As an alternative to the problem of subjectivity, the method of formalized content analysis, often referred to as content analysis, emerged. The first computer program created for qualitative text analysis is considered to be F. Stone's General Inquirer program. Today, this program includes 182 semantic categories and a dictionary with more than half a million words, aligned with these categories (. Project, 1974). The technical aspects of the method were emphasized by F. Cole, who asserted that content analysis, from a technical point of view, involves the analysis of the form and content of texts and information sources, namely their processing, evaluation, and interpretation. Through this analysis, it is possible to investigate objects, phenomena, processes, and properties of social reality using texts (Cole, 1988).

Among the pioneers who studied this method were R.Rich, C. Brians, J Manheim. Their perspective on content analysis primarily focused on its quantitative characteristics (frequency, summation, statistical indicators). They defined content analysis as a systematic numerical processing, evaluation, and interpretation of the form and content of information (Manheim et al., 2012). B. Berelson, who is also considered a founding figure of the method, held a similar view. He defined content analysis as "a research technique for the objective, systematic, and quantitative description of the manifest content of communication according to the objectives of the researcher" (Berelson, 1971).

With the development of the method, it began to be seen as both quantitative and qualitative, and researchers gained more freedom in creating categories and choosing their approach.

Semantic-analytical analysis of large volumes of political and sociological content was studied by V. Ivanov (Ivanov, 1986).

With the advent of the Internet, an almost endless source of text documents emerged, leading to the development and implementation of specialized computer programs. However, the majority of applications today fall into three types: specialized automated packages for content analysis, universal packages for word frequency calculation in texts, and semi-automatic packages for manual coding of textual data.

In conclusion, content analysis is a method that allows researchers to study objects, phenomena, processes, and properties of social reality represented in textual data. It involves processing, evaluating, and interpreting the form and content of texts and information sources. Regardless of the approach to content analysis (traditional or computer-based), it is important to teach students to understand its significance for fostering critical thinking, its essence, and the logic of conducting it. The use of IT technologies for content analysis is also relevant.

The objective of the article is as follows: theoretical and practical justification of implementing interdisciplinary connections between sociology and Informatics with the Introduction of computer content analysis methods for developing students' critical thinking and experiment results verification.

MATERIALS AND METHODS. theoretical research methods: we conducted an analysis and synthesis of scientific sources to uncover the fundamental principles related to the research problem. empirical research methods: we utilized various empirical techniques such as surveys, observations, and interviews. statistical methods for processing respondent data: we employed statistical approaches to process and analyze the results of the surveys conducted with the respondents.

RESEARCH RESULTS

The practical implementation of the idea of integrating interdisciplinary connections between "Computer Science" and "Sociology" for the application of computerized content analysis methods entailed several key steps. This approach was intended for students, irrespective of their specialization, and included the following elements:

1. **Curriculum integration**: The first step involved integrating the subjects of "Computer Science" and "Sociology" into the educational plans for students. This meant that regardless of their chosen major, students were exposed to both disciplines.
2. **Theoretical foundation**: When studying sociological topics such as "Social Behavior and its Influencing Factors," "Political Sociology," "Sociology of Religion," and "Sociology of Conflict," students were provided with theoretical knowledge about the essence of content analysis. They learned about its characteristics, advantages, and limitations. An algorithm for performing content analysis was also provided to guide them through the process.
3. **Problem formulation and sociological research**: To apply content analysis, problem questions were formulated related to social phenomena. For example, students explored topics like youth attitudes toward politics, social conflicts in Ukraine, and the necessity of further development in the sociology of religion. Any available sources of information, including internet resources, media, textbooks, archival documents, surveys, political party programs, social media posts, and comments, were analyzed.
4. **Computerized content analysis in computer science**: simultaneously, computer science laboratory assignments were designed to focus on a similar analysis of phenomena but using computerized content analysis methods. the following topics were covered:
   - Conducting content analysis in Microsoft Word and Microsoft Excel with the interpretation of results.
   - Utilizing specialized content analysis software like QDA Miner Lite.
   - Visualizing and presenting the results of content analysis.
5. **Content Analysis Algorithm**: The standardized procedure for conducting content analysis with computer methods consisted of the following steps:
   - Problem definition: selecting information sources and entering them into a database. These sources included articles, advertising slogans, texts, social media posts, consumer reviews, and more.
   - Data formalization: textual information was structured based on qualitative criteria, such as uniformity of text

fragments, text fragment size, and the type of information source.

– Category selection: identifying categories for analysis, which could include the frequency of certain terms in the text, emotional tone, or characteristics of events.

– Data analysis: this involved encoding, segmenting texts into fragments, creating a content analysis dictionary, and performing a factor analysis of the dataset.

– Quantitative analysis: the quantitative analysis of the data was conducted to answer questions such as how many times a particular object was mentioned or whether the frequency of mentions changed over time.

– Qualitative Analysis: qualitative analysis allowed for the discovery of relationships between text fragments and the differences between mentions of various objects.

– Conclusions: based on both quantitative and qualitative analyses, conclusions were drawn, and an analytical report was generated.

The approach recommended introducing students to classical content analysis using office software (Microsoft Word and Excel) before delving into more complex methodologies and specialized software. The inclusion of this structured process in the curriculum ensured that students comprehended the fundamental principles and the logic of content analysis. This educational sequence provided a strong foundation for more advanced content analysis methods.

RESULTS OF THE PEDAGOGICAL EXPERIMENT

To assess the effectiveness of teaching students computerized content analysis methods for sociological research in Sumy's s, an experiment was conducted. The experiment involved students from the Sumy of Economics and Trade, who constituted the experimental group (EG) with 26 students, and students from the Sumy of the National University of Food Technologies, comprising the control group (CG) with 23 students.

All students were in their second year, and their curriculum included courses in "Computer Science" and "Sociology." While studying sociology topics such as "Social Behavior and Its Formation Factors," "Political Sociology," "Sociology of Religion," and "Sociology of Conflict," thematic sociological research was conducted. Subsequently, the research results were analyzed, and based on this analysis, students prepared analytical reports. The analytical reports by students, serving as control snapshots at the beginning and end of the experiment, were assessed using a 10-point grading system. The criteria for evaluating the analytical reports are outlined in Table 1.

Table 1.

Criteria for Evaluating Analytical Reports

Criterion	**Points**
Demonstration of systematic procedural knowledge	1
Display of creative abilities	2
Use of a range of tools to support and substantiate one's viewpoint	2
Logical coherence and consistency of thoughts	1
Presence of well-founded conclusions	2
Attempt at providing an adequate prediction of social phenomena	1
Visualization of the results of content analysis	1
Total	**10**

At the outset of the experiment, both the experimental and control groups engaged in sociological research and the creation of analytical reports using conventional (classical) methods. Throughout the experiment, the laboratory exercises within the "Informatics" discipline for the experimental group were geared towards the study of computer-based methods and tools for conducting content analysis of sociological research. At the conclusion of the experiment, a reevaluation of the analytical reports was conducted using the specified criteria. The outcomes of these calculations are presented in Figure 1.

	A	B	C	D	E	F	G	H	I
1	sections at the beginning and at the end of the experiment								
2	№	At the beginning of the experiment		At the end of the experiment					
3		EG	KG	EG	KG		P test	0,00000056	
4	1	5	6	8	6				
5	2	7	6	8	7		P < 0,05		
6	3	6	7	7	6				
7	4	7	7	7	6				
8	5	6	8	8	7				
9	6	7	4	9	5		Two-sample t-test with different variances		
10	7	6	4	8	5				
11	8	6	4	8	6			EG	KG
12	9	6	5	8	5		Avarage	7,46154	6
13	10	5	5	7	5		Dispersion	0,81846	0,90909091
14	11	4	5	7	5		Observation	26	23
15	12	4	5	7	4		Hypothetical mean difference	0	
16	13	4	6	8	7		df	46	
17	14	5	7	9	7		t-stat	**5,48486**	
18	15	6	6	9	7		P(T<=t)	8,5E-07	
19	16	6	7	9	6		T kr	1,67866	
20	17	7	6	7	6		P(T<=t)	1,7E-06	
21	18	8	6	7	5		t kr	**2,0129**	
22	19	6	6	7	7				
23	20	5	6	7	7		**texp> tkr**		
24	21	7	5	7	7				
25	22	7	6	6	6				
26	23	5	7	6	5				
27	24	7	8	7	7				
28	25	5		7					
29	26	6		6					
30	27	7		8					
31	Avarage	5,93	5,92	7,48	6,00				
32	Increase			1,56	0,08				

Fig. 1. Results of statistical processing of experiment data

In the results of the subsequent control assessment at the conclusion of the experiment, a favorable trend becomes evident. Upon analyzing the control assessments in both the Experimental Group (EG) and the Control Group (CG), the average score in the EG increased by an average of 1.56, while in the CG, it rose by 0.08.

Comparatively, the EG exhibited improvements in scores across several evaluation criteria. These criteria included the utilization of resources for substantiation, the logical coherence of ideas, the presence of well-founded conclusions, and attempts at adequately forecasting social phenomena. Students in the EG, enabled by the utilization of computer-based content analysis methods, had access to a larger database of information sources on various sociological research topics. This access enabled them to showcase a higher level of objectivity in their judgments, further supported by statistical computations.

To illustrate the effectiveness of the implemented educational methods for teaching computer-based content analysis, a statistical hypothesis test was conducted using the t-Student test for two independent samples.

Two hypotheses were formulated: H_0: There is no observed effectiveness resulting from the employed teaching methods. H_1: There is indeed an observed effectiveness stemming from the employed teaching methods, and it is statistically significant.

The statistical analysis results were computed using the MS Excel analysis package. The corresponding probability for the t-Student test was calculated using the T.TEST function. The T.TEST function (D4:D30; E4:E27; 2; 3) was applied, and the Data Analysis tool was also utilized.

Based on the calculated results, $P < 0.05$; $t\text{-exp} = 5.485 > t\text{-kr} = 2.013$. In both applications of the t-Student test, the evidence suggests the acceptance of the H_1 hypothesis and the rejection of the null hypothesis.

In conclusion, we can confidently assert, with statistical backing, the effectiveness of the proposed methods within the experimental group at a significance level of 0.05.

CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

Consequently, the pedagogical experiment and its outcomes lead to the following deductions. The provided algorithm for implementing interdisciplinary links between computer science and sociology through the application of computer-based content analysis methods plays a vital role. It cultivates critical and algorithmic thinking among students, elevates their information technology proficiency, inculcates the skill to assess the properties of information streams, and enriches their comprehension of information conflicts.

The efficacy of this approach is underscored by the results of the subsequent control evaluation, particularly the positive trend in average scores within the Experimental Group (EG) as compared to the Control Group (CG) at the conclusion of the experiment. Notably, scores have improved across various assessment criteria: the utilization of resources for substantiation, logical cohesiveness of ideas, the presence of well-grounded conclusions, and the endeavor to provide an adequate forecast of social phenomena. In light of the use of computer-based content analysis methods, EG students had the opportunity to analyze a more extensive array of information sources across diverse sociological research topics. This allowed them to showcase a higher level of objectivity in their judgments, bolstered by their statistical computations, the visualization of research, and attempts at making predictions.

The validation of statistical hypotheses using the t-Student test for two independent samples at a significance level of 0.05 duly attested to the significance of the H_1 hypothesis (the effectiveness of the applied teaching methods) while refuting the H_0 hypothesis.

Looking ahead, we envisage further exploration of computer-based content analysis methods, with the prospect of integrating these algorithms into other fields, including finance and commerce. Furthermore, it is imperative to delve deeper into the study of specialized computer programs such as Yoshikoder and TextAnalyst.

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ВИКОРИСТАННЯ КОМП'ЮТЕРНИХ МЕТОДІВ КОНТЕНТ-АНАЛІЗУ ДЛЯ АКТИВІЗАЦІЇ КРИТИЧНОГО МИСЛЕННЯ СТУДЕНТІВ

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Анотація.

Постановка задачі. *У статті розглядається питання виховання критичного мислення в учнів за допомогою аналізу змісту документів. Описано педагогічний експеримент з інтеграції соціології та інформатики для студентів з метою оволодіння комп'ютерними методами контент-аналізу для соціологічних досліджень.*

Матеріали та методи. *Використано аналіз та узагальнення наукових джерел для розкриття фундаментальних принципів, пов'язаних з проблемою дослідження. Використано різні емпіричні методи, такі як опитування, спостереження та інтерв'ю. Також ми використовували статистичні підходи для обробки та аналізу результатів опитувань, проведених з респондентами.*

Результати. *Про ефективність експерименту свідчать результати повторної контрольної оцінки, зокрема позитивна динаміка середніх балів у групі ЕГ порівняно з КГ наприкінці експерименту. Спостерігається помітне зростання балів за різними критеріями оцінки, такими як використання різноманітного інструментарію для обґрунтування, логічна послідовність мислення, наявність обґрунтованих висновків, спроба точного прогнозування соціальних явищ*

Висновки. *Запропонований алгоритм реалізації міждисциплінарних зв'язків між інформатикою та соціологією за допомогою використання комп'ютерних методів контент-аналізу має важливе значення. Це формує в учнів критичне та алгоритмічне мислення, підвищує їх компетенцію в галузі інформаційних технологій, виховує їх здатність оцінювати властивості інформаційних потоків та розуміти природу інформаційних конфліктів.*

Ключові слова: *критичне мислення, контент-аналіз, комп'ютерні методи аналізу, , аналіз текстових даних, студенти.*