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BEHAVIORAL INSIGHTS IN EDUCATION: INTELLECTUAL DATA ANALYSIS FOR MANAGEMENT

Irina Radionova
Kyiv National Economic University named after Vadym Hetman, Ukraine

Vira Usyk
Kyiv School of Economics, Ukraine

Yana Fareniuk
RAZOM GROUP, Kyiv, Ukraine

ABSTRACT

This research utilizes intellectual data analysis to deepen insights into educational dynamics by examining university professors' behavioral responses to education management amidst socioeconomic uncertainty. The study applied sophisticated regression and cluster analysis tools to sociological survey data, focusing on professors' attitudes toward distance education. The survey assessed perceptions of its advantages and disadvantages, aiming to uncover factors influencing professors' inclinations toward this mode of teaching. Results revealed six distinct behavioral "profiles" or clusters of professors, each with unique responses to distance education. These insights guide recommendations for educational policy priorities aimed at addressing weaknesses in education management. Key strategies proposed include forming databases of behavioral responses and employing algorithms for deep intellectual analysis. Such measures intend to align educational practices with the values, welfare needs, and communication preferences of the scholarly community, thereby enhancing their propensity for distance education. The study concludes that a higher level of academic engagement in distance education can be achieved by tailoring educational strategies to the specific needs and values of different professor groups. This approach promises to improve the effectiveness of education management and the overall quality of education, benefiting both professors and students by creating a more supportive and effective teaching environment.

Keywords: Intellectual analysis; behavioral economics; education management; behavioral reactions; education process; distance education

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INTRODUCTION

This study was conducted within the behavioral economics scientific sphere. Therefore, it is based on the ideas and generalizations of behavioral theory. The contribution of this study to the development of the above-mentioned scientific sphere is determined by the subject of the study, which is

the behavioral reactions of university professors working under conditions of high socioeconomic uncertainty. The behavioral reactions of university professors are studied on the basis of sociological survey data using the Intellectual Data Analysis Toolkit.

The analysis of behavioral responses of participants in the educational process has already been the subject of many studies, which is reflected in the literature review below (Aristovnik et al., 2020; Bania & Banerje, 2020; Bao, 2020). However, this study places special emphasis, namely, on the peculiarities of behavioral responses that should be taken into account when making managerial decisions in education when educational services are provided in emergency conditions and involve the use of new relevant forms of education.

The need for this study is determined by the lack (or restricted understanding) of participant behavioral responses in emergencies within the educational process. New management decisions in education may be based on information regarding the characteristics of these reactions. This study also stands out from others because it focuses on the behavioral responses of university professors, whereas most studies focus on the behavioral responses of students and learners (Aristovnik et al., 2020; Brooks et al., 2021; Arcinas et al., 2021).

The theoretical framework of behavioral economics is used in this study, including concepts, assumptions, logic of reasoning, etc. The intellectual data analysis on the behavioral responses of professors should serve as the foundation for awareness of the necessary changes in education management (Arcinas et al., 2021; Zhang et al., 2022; Yağcı, 2022; Khan & Ghosh, 2021). Two tools of intellectual data analysis were used in the study, namely regression and cluster analysis. The analysis identified the main factors influencing an important behavioral variable, defined as the" propensity of professors to distance education." The analysis also resulted in the identification of separate clusters ("profiles") in the community of university professors. It was found that university professors, despite belonging to the same community, differ (within clusters) in such behavioral characteristics as preferences, values, inclination to certain educational actions, etc. The generalization is made that correctly identified factors influencing the “propensity of professors”, as well as "profiles" of professors, can be used for the adjustment of educational management and educational policy.

LITERATURE REVIEW

The literature review on the issue defined in the title of this article should cover the following directions: 1) the study of educational management issues, particularly distance education during emergencies; 2) behavioral approaches and behavioral economics theory; and 3) research in the educational sphere using intellectual analysis of data.

Behavioral approaches and behavioral economics theory serve as the methodological foundation of the study. This area of contemporary research must be directly focused on management strategies that are used in the socioeconomic sphere. We, therefore, have relied on publications that outline the overall framework and core concepts of behavioral economics theory. These specifically include the writings of Lehr (2021), Sunstein, Cass R. (2016), Misbehaving (2015), Thaler (2018), and Cartwright (2018).

Numerous scientists have acknowledged the feasibility of using behavioral economics methods in education research. Wang et al. (2020) analyzed behavioral aspects related to how students interact with educational content, focusing on predicting student responses and enhancing personalized learning through machine learning models. Noor et al. (2022) delved into how digital learning platforms influence students' behavioral engagement in learning activities. Corlane et al. (2018) highlighted the importance of supportive cultural practices and access to necessary technology as key to facilitating positive behavioral responses toward e-learning, especially in developing economies. The tradition of using behavioral economics in educational sphere studies has continued in the works of Anderberg & Cerrone (2015) and Vevere & Mons (2020).

Numerous authors who looked into the issue of changing the educational paradigm in general and in the period of COVID-19 acknowledged the impact of behavioral elements. In particular, Nepal & Rogerson (2020) singled out the determining behavioral factors of distance learning, which should be taken into account when changing educational policy. The works of

Aristovnik et al. (2020)., Bania & Banerje (2020), Yeung & Yau (2022), Bao (2020), Berezhna & Prokopenko (2020), Bozkurt et al. (2020). Hodges et al. (2020), Rapanta et al. (2020), Hu & Syang (2020), Jayadeva et al. (2022), and Brooks et al. (2021) assess education process participants' attitudes as well as the government's capacity to change education policy. Especially important for our research are works that are devoted to the influence of main participants (actors) of the educational process who are involved (tangential) in education policy. One such work, for example, is Barners (2021). The works devoted to the problem of the social function of modern universities in the 21st century are also crucial for our research. This is, for example, work by Rodriguez-Pomeda & Casani (2022). The work of Yasdin et al. (2020) is devoted to critical behavioral aspects of educational policy organization, such as stakeholder interaction and partnership. It is not only about the main actors in the educational process but also about representatives of legislative and executive authorities, businessmen, educational agents, and professors' associations.

Additionally, there is a need to review the scientific research related to intellectual data analysis (Data Mining). For this study, we used intellectual data analysis tools. In such conditions, the works that outline the possibilities, particularities, benefits, and unique issues that data Mining may answer are crucial to our research. The works of Sivasakthi (2021), Subirats et al. (2023), and Chernyak & Zaharchenko (2014), in particular, present the solutions to these issues and describe the main areas of data mining implementation, the specifics and opportunities from different Data Mining techniques, for example, regression analysis, methods of clustering and classification. There are also works in scientific circulation that are devoted to research in the educational sphere, specifically with the use of intellectual data analysis. “Data mining applications in university information management system development” (Zhang et al., 2022) is an example of this kind of work.

The widespread availability of e-learning datasets further enhances the application of data mining, especially in online education. Among the applications of intellectual data analysis in education, the problem of modeling student performance is important. Educational data mining has become an effective tool for exploring the hidden relationships in educational data and predicting students' academic achievements (Yağcı, 2022). Khan & Grosh (2021) focused on predicting performance before starting education. Arcinas et al. (2021) investigated the characteristics that influence students' choice of a field of study in higher education. There are different data mining techniques for educational data mining (intelligent data analysis), both supervised (classification and regression) and unsupervised (clustering and association) (Nachaouki et al., 2023).

METHODOLOGY

Because the primary problem of this study is to obtain deeper insights of the educational sphere for education management based on the study of behavioral responses, the methodological basis of this study is the theory of behavioral economics. The study is based on the ideas of the theory of behavioral economics, which is the basis of the quantitative method of research.

Another methodological basis of this research is the idea of the theory of intellectual data analysis. The in-depth processing of information to get new (previously little-known or unknown) knowledge as well as their pertinent interpretation while making management decisions, are the distinguishing characteristics of the intelligent data analysis used in this study. We concentrate on the following three aspects of intellectual data analysis: 1) detailed database processing, 2) the search for new knowledge that goes beyond traditional concepts, and 3) the direct focus of research on the justification of applied management decisions.

The study of behavioral responses in the educational sphere, data for which was obtained from a sociological survey, was conducted using the methodology of sociological analysis. Thus, the research approach used in this study involves a combination of quantitative and qualitative methods.

RESULTS

The research makes use of the following fundamental ideas of the theory of behavioral economics in view of its primary issue.

First, it is a recognition of the imperfection of automatic regulators of social processes, which (imperfection) usually increases with increasing uncertainty.

Second, it is a fundamental assumption about the so-called "limited (incomplete) rationality" of people's behavioral reactions. We are particularly impressed by the explanation of this "limited rationality" by the tendency of decision-making subjects to reject (deny) those alternative choices that do not agree with people's previously formed vision of events.

Third, it is the recognition of so-called "limited egoism", in which private interest does not always prevail over the interest of communities. We are talking about situations when people's behavior is significantly influenced by the inclination to sacrifice and reciprocity. Therefore, subjective usefulness is interpreted differently than in neoclassical economic theory. In the theory of behavioral economics, usefulness is a function of fairness and interaction.

Generalizations regarding behavioral reactions to the distance form of education are made in this study on the basis of a sociological survey of 194 professors at 28 Ukrainian universities. The survey was conducted in February-April 2022. The survey concerned aspects of reactions to distance learning, such as inclination to it, assessment of advantages and disadvantages, opportunities and limitations, and various motivational factors. The questionnaire for the professors covered 9 main questions and 2 additional ones. Ukrainian experts in the field of education management confirmed the relevance of the questions in the questionnaire. According to the authors of this article and experts, the questionnaire reflected the problematic issues of the organization of Ukrainian education, carried out in a remote form during a period of high uncertainty - the COVID-19 pandemic and the active phase of the war. The questionnaire contained questions that made it possible to assess the behavioral responses of professors to the most important components of distance education: its content, comfort, the Possibility of using digital technologies, the connection with other forms of activity of teachers, etc.

This study's primary focus was an extensive conceptual analysis of the sociological survey database. Table 1 displays the questions offered to Ukrainian university professors.

Table 1. The questionnaire: "Your attitude to a completely online form of learning"

Main questions for respondents:
1. Your attitude to a completely online form of learning 1.1. Quite positive 1.2. More positive than negative 1.3. More negative than positive 1.4. It is difficult to determine
2. Your attitude to a partially online (blended) form of learning 2.1. Quite positive 2.2. More positive than negative 2.3. More negative than positive 2.4. It is difficult to determine
3. What do you think is the most significant advantage of online education? (in both its manifestations - full and partial) 3.1. Opportunity to save time and money on travel and transportation and avoid other expenses. 3.2. Possibility of receiving a set of professor's teaching materials in electronic format 3.3. Possibility of creative use of modern technologies 3.4. Additional advantages
4. What do you think is the most significant disadvantage (restriction) of online learning in both its full and blended forms? 4.1. A lack of human (live) communication with other educational participants, such as students, professors, and administrators.

Table 1. Continued

4.2. Online education incurs additional costs (gadgets, communications, etc.) 4.3. Additional time expenses owing to the necessity to update materials on a regular basis and the need to learn new technologies. 4.4. Additional disadvantages 5. Do you consider online learning classes to be more meaningful in the sense that they contribute to the acquisition of knowledge and the development of competencies as specified by educational programs? 5.1. Have become more meaningful 5.2. They have, for the most part, become more meaningful. 5.3. They have not, for the most part, become more meaningful. 5.4. Didn't feel any change 6. Have online learning classes become more convenient for you in terms of form, such as those that provide comfort, a pleasant learning environment, and so on? 6.1. They have become more convenient 6.2. They have become more convenient, for the most part 6.2. They haven't become more convenient, for the most part 6.4. They haven't become at all. 7. How has your time for preparation for classes and other work related to online learning, in particular - to checking the completed tasks changed? 7.1. Time has increased. 7.2. Time has decreased 7.3. Time remained unchanged 7.4. Difficult to answer 8. Does online learning enable you to combine work at your primary job with work elsewhere? 8.1. It helps. 8.2. It helps rather than not 8.3. It doesn't help, rather than helps 8.4. Doesn't help at all 9. Does online learning allow you to balance work at your primary job with your professional and personal development? 9.1. It helps. 9.2. It helps rather than not 9.3. It doesn't help, rather than helps 9.4. Doesn't help at all
Additional research questions (factors)
1. On the basis of work with students of which year the professor draws conclusions 2. University rating

Source: author's work.

The answers and questions of this questionnaire were investigated using regression and cluster analysis tools.

The regression analysis's findings indicated the following factors influencing the endogenous behavioral variable - "attractiveness of distance learning," which can be interpreted as the "propensity to distance learning" of university professors. This variable was evaluated on the basis of the positive - "Quite positive" and "More positive than negative" - responses of the survey participants to the question of the questionnaire: "Your attitude to a completely online form of learning." (The questionnaire is presented in Table 1.)

The model of factor influence on the so-called "propensity to distance learning" of professors of Ukrainian universities turned out to be the most

adequate. The results of the regression analysis are presented in Table 2. The model is sufficient as F-statistics = 19.25 and p-value = 0.00, which is less than 5%. This value corresponds to the criterion of 95% probability of correct construction of the model and determining the significant influence of the outlined list of factors.

Table 2. The results of the regression analysis, according to the sociological survey of professors of Ukrainian universities

Variable	Coefficient	Stand. Error	t-statistics	p-value
Constant	-0.24127	0.102822	-2.3465	0.02
MMF_{Pr}	0.111374	0.027071	4.114072	0.00
MCF_{Pr}	0.064121	0.029503	2.173365	0.03
BW_{Pr}	0.062354	0.025494	2.445878	0.02
PMT	0.110087	0.062704	1.755662	0.08
LNC_{Pr}	-0.08523	0.07197	-1.18422	0.24
Multiple R	58.2%		F-statistics	19.25
R^2	33.9%		p-value	0.00
Adj. R^2	32.1%			

Source: author's work.

The regression equation of the factor influence regarding the "propensity of professors" to distance education has the following form:

ADE_{Pr} = -0.24127 + 0.111374 MMF_{Pr} + 0.064121 MCF_{Pr} + 0.062354 BW_{Pr} + 0.110087 PMT – 0.08523 - LNC_{Pr}

(where, ADE_{Pr} – attitude to distance education (or propensity of professors to distance education»); MMF_{Pr} - more meaningful form; MCF_{Pr} - more convenient form, BW_{Pr} - combine work at primary job with work elsewhere, PMT - possibility of creative use of modern technologies, LHC_{Pr} - lack of human (live) communication with other educational participants)

The results of the regression analysis show that the comfort of this form of education, the Possibility of combining work at the primary location with work in other locations, and the potential for innovative use of contemporary technologies in the educational process are all directly related to professors' preferences for distance learning (such factors are significant in the constructed model as the p-value are less than 0.05 (95%-probability and less than 5% for an error).

It turned out that the main influences on a professor's inclination are the educational content and the potential for creative usage of contemporary technologies. It was discovered that the lack of live communication throughout the remote learning process is the only factor in the inverse relationship between professors' commitment to the distance form.

The cluster analysis used in this study performed a different (compared to regression analysis) function. Regression analysis made it possible to investigate the community of professors as a whole. It was found that the behavior of this integrity is determined by five influential factors. Instead, cluster analysis makes it possible to distinguish groups (clusters) in the community of professors. According to the results of the cluster analysis, six clusters were singled out, which are interpreted as special "profiles" of professors with special (somewhat different) behavioral responses to distance education.

The cluster analysis toolbox is frequently used in the implementation of intellectual analysis, involving cluster analysis of elements (segments) or the objects being researched while simultaneously applying a number of criteria (criterion features). The benefits of using a multi-criteria approach in behavioral reaction research are clear. After all, a variety of factors combine to shape the preferences and choices of the subjects of socioeconomic processes.

Clustering was carried out using Kohonen's algorithm. As a result, "Kohonen maps" were

developed and interpreted. The Deductor Studio program, which includes the Kohonen algorithm and a unique Kohonen map visualizer, was used to perform the clustering process. The cells in the map also demonstrated clustering using special K-means and G-means algorithms.

Six clusters were detected after segmenting the professors in this study using the K-means algorithm. The attempt to prevent the extra issue of so-called "overtraining" and an overly high number of clusters is the reason the G-means algorithm was rejected. The latter could make it impossible or much more challenging to read cluster analysis results clearly.

Figure 1 shows the clustering outcomes when segmenting university professors in the form of a developed Kohonen map.

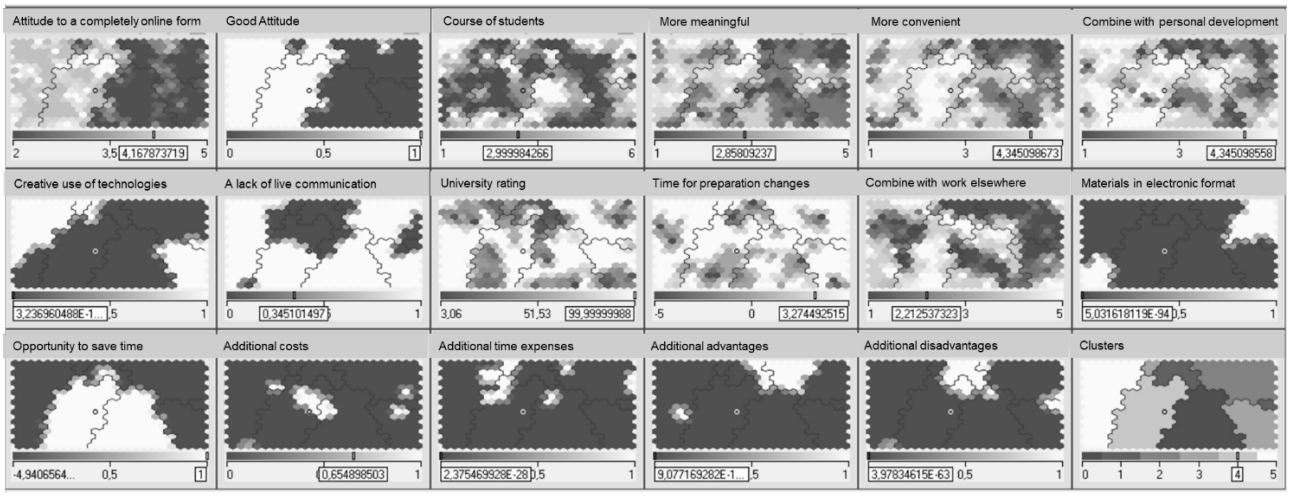

Figure 1. "Kohonen's map" when segmenting professors

Source: author's work.

Table 2 contains the information needed to describe what is depicted in Figure 1. The word "cell" is used to denote each element on the map in Figure 1, together with the relevant index. The first digit of the cell index and the picture column by the second represent the tape.

Table 2. The content of the "Kohonen map" when clustering professors

"Kahonen map" cells	The content of what the cell illustrates (according to the questions answered by professors in the survey)
Cell 1.1	"Your attitude to a completely online form of learning"
Cell 1.2	Response-based distance learning propensity information: "Quite positive" + "More positive than negative"
Cell 1.3	**Information on the courses** that professors used to respond to the questionnaire's questions regarding their experience with distant learning.
Cell 1.4	"Do you consider online learning classes to be more meaningful, in the sense that they contribute to the acquisition of knowledge and the development of competencies as specified by educational programs?"
Cell 1.5	"Have online learning classes become more convenient for you in terms of form, such as those that provide comfort, a pleasant learning environment, and so on?"
Cell 1.6	"Does online learning assist you in combining university work with your professional development, i.e., personal development?"
Cell 2.1	"What do you think the biggest advantage of online education is?». Answer: "Possibility of creative use of modern technologies."

Table 2. Continued

Cell 2.2	"What do you think the most significant disadvantage (restriction) of online learning in both its full and blended forms is?". Answer: "A lack of human (live) communication with other educational participants, such as students, professors, and administrators."
Cell 2.3	The university's ranking in the All-Ukrainian ranking of universities
Cell 2.4	"How has your time for preparation for classes and other work related to online learning, in particular - to checking the completed tasks changed?"
Cell 2.5	"Does online learning enable you to combine work at your primary job with work elsewhere?"
Cell 2.6	"What do you think the biggest advantage of online education is?" Answer: "Possibility of receiving a set of professor's teaching materials in electronic format."
Cell 3.1	"What do you think the biggest advantage of online education is?". Answer: "Opportunity to save time and money on travel and transportation and avoid other expenses."
Cell 3.2	"What do you think is the most significant disadvantage (restriction) of online learning?" Answer: "Online education incurs additional costs (gadgets, communications, etc.)"
Cell 3.3	"What do you think is the most significant disadvantage (restriction) of online learning?" Answer: "Additional time expenses owing to the necessity to update materials on a regular basis and the need to learn new technologies."
Cell 3.4	"What do you think the biggest advantage of online education is?". Answer: "Additional advantages"
Cell 3.5	"What do you think is the most significant disadvantage (restriction) of online learning?". Answer: "Additional disadvantages"
Cell 3.6	The main result of clustering is the separation of six cluster limits based on a certain set of factors that reflect the attitude of professors to the distance form: 5th, 4th, 3rd, 2nd, 1st, 0^{th}

Source: author's work.

The following patterns of segmenting professors by clusters were discovered based on the clustering that was used:

- Only representatives of clusters 4 and 5 are professors who are completely satisfied with the distance form;
- Representatives of clusters 4 and 5 most often note that distance learning makes it possible to combine work with self-development;
- Representatives of all clusters, except 1 and, partially, 4, note that the lack of live communication is the main disadvantage of the distance form;
- Representatives of all clusters recognize the fact that the time for preparing classes in distance form is increasing;
- Representatives of clusters 4 and 0 fix saving time and travel costs as an advantage.

The following "profiles" of each cluster can be formed on the basis of the identified features of segmentation of professors:

- Cluster 0 - professors who are dissatisfied with the remote form, who mainly work with senior courses of universities with a lower rating (outside the top 50 universities), and who do not fix the Possibility of creative use of modern technologies, and recognize the saving of travel time as the main advantage;
- Cluster 1 – partially satisfied professors working with senior courses at the best universities (place within the 50 best universities);
- Cluster 2 - professors who are dissatisfied with the remote form, who, despite this, note that the classes have become more meaningful and allow to combine work with self-development;
- Cluster 3 - dissatisfied professors who, nevertheless, note the Possibility of creative use of modern technologies.

Cluster 4: satisfied professors who, for the most part, acknowledge the convenience and greater meaningfulness of the lessons, the opportunity for self-improvement, the inventive use of modern technologies, the blending of work at the primary location with other work, and the time-saving for commuting;

Cluster 5 - professors who are satisfied with the distance form, who note that classes have become more meaningful and more comfortable, and also recognize the Possibility of self-development when using this form.

From the provided "profiles" of professors of specific clusters, at least the following management generalizations may be made:

First, the critical attitude towards distance education is not directly related to the "retrogradeness" of professors. After all, the fact of the Possibility of self-development, creative use of modern technologies, and greater content of the educational process is recognized by both professors who have shown an "inclination" to this form and those who have not. The latter can be interpreted in such a way that for professors who are "not committed" to the distance form, the negative aspects of its organization outweigh the positive aspects that these professors are aware of. It is quite obvious that the most important organizational points for professors are the rationing of hours and payment of labor. Therefore, management changes should, first of all, be related to rationing and stimulation.

Second, since senior-year professors at the best universities express some partial satisfaction with the distant form, this can be read from a management perspective as follows:

1) The management of distance education in senior courses needs improvement and attention, and

2) the level of organization of the distance form should be a significant component of evaluation in the officially recognized ranking algorithm of universities, which is a tool of influence of central authorities on education.

DISCUSSION

We conclude from this study that a variety of factors, including those related to the content, have an impact on the behavioral phenomenon known as "the general propensity of professors to distance education". These factors include issues associated with this community's value guidelines, level of well-being, necessity of communication, etc. The community under study is diverse even though it is cohesive. This behavioral phenomenon has not been the subject of research in other works on the analysis of behavioral responses of participants in the educational process. However, it is essential to make managerial decisions in education.

The list of factors influencing the "propensity of professors to distance education" was quite predictable. However, the fact that only two out of the six clusters of professors have an entirely positive attitude towards distance education was unexpected. Positive attitudes about the remote form are correlated in these two groups with the use of contemporary technologies, professors' self-improvement, and their awareness of chances to improve the educational program. The attitudes of the professors in the other four clusters were either entirely or primarily negative toward distance learning. Furthermore, there is a negative attitude that is correlated with higher labor intensity, a failure to take advantage of digital technology, and a lack of opportunities for personal growth.

We believe that the study's findings confirm the idea of limited or partial rationality, which supporters of the behavioral economics theory highlight. Teachers exhibit a unique kind of logic wherein "non-egoistic" and "non-material" incentives become just as important as material and self-centered ones. Another part of this study is "bounded rationality" from the theory of behavioral economics by this, we mean the logic of distinct professor clusters (or "profiles") that distinguish them within the boundaries of a larger community.

Three aspects of the scientific problem research analyzed in this article can become the subject of further discussion. First, it is a method of identifying the behavioral reactions of the main subjects of the educational process. It (the method) is related to the content of the questionnaire of the sociological survey used in the study. The content of the questions of the questionnaire and the way they are presented bear the imprint of the subjective vision of the tasks, problems of education, and pedagogical experience of the authors of this article.

Second, the interpretation of the findings from intellectual data analysis, particularly the clustering results, can be the topic of discussion. The problem of interpreting the results in our

case is related to the so-called "profiles" of professors, as it concerns "profiles" based on six isolated clusters. It was evident that different clusters may arise in other research when using different classification features. As a result, conclusions about clusters and "profiles" could vary.

Third, the subject of discussion may be the extent to which the peculiarities of the behavioral reactions of the subjects of the educational process found out by researchers should become the basis for changes in the educational policy of governments. In particular, it is about whether the educational policy should always be formed "in advance of the needs" of the subjects of the educational process or, on the contrary, should the policy perform the function of "anticipating the event" and form new needs of the participants of the educational process.

CONCLUSION AND RECOMMENDATION

On the basis of the generalizations we have made regarding the peculiarities of the behavioral reactions of the participants of the special form of the education process, we single out those priorities of education policy, the implementation of which can limit the "weak" aspects of the education process. Namely:

The primary justification for changes in educational management and educational policy should be generalizations and conclusions drawn from the results of ongoing discussions with educational process participants – university professors. Communication in the form of ongoing sociological surveys of professors is the main focus. The system for collecting data from educational process actors should be performed in accordance with the expert-determined database creation algorithms and their in-depth intellectual analysis.

For the identification of the factors that influenced the "propensity of professors to distance education" and the so-called "professor profile" for a country, a separate university can be used in the formation of educational policy. We mean the problems, goals, and tools that can be identified and clarified in the sociological research of the behavioral reactions of the actors of the education process.

Education management decisions ought to consider the behavior of their professors. This does not negate the fact that the student's behavioral responses play a decisive role in these decisions. Unfortunately, not all of the issues faced by professors who operate in new, more complicated, uncertain settings are reflected in the regulatory documents on education, which Ukrainian managers of education and providers of educational services draft. Thus, the basis for enhancing educational policy is the behavioral reaction features found in this study.

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ABOUT THE AUTHORS

Vira Usyk, e-mail: vivayoung70@gmail.com (Corresponding author)

Dr. Irina Radionova is a Professor at Kyiv National Economic University, named after Vadym Hetman (Department of Economic Theory) and the head of the theoretical and applied economics department of KROK University.

Dr. Vira Usyk is a Professor and Academic Director of MA in Public Policy and Governance at Kyiv School of Economics. She teaches policy analysis and has more than ten years of experience in projects as a trainer, facilitator, and mentor.

Dr. Yana Fareniuk is the Chief Data Scientist y RAZOM GROUP. She is a leading specialist in the development and implementation of mathematical modeling and data analysis.