МАТЕМАТИКА И МАТЕМАТИЧЕСКО ОБРАЗОВАНИЕ, 2016
MATHEMATICS AND EDUCATION IN MATHEMATICS, 2016
Proceedings of the Forty Fifth Spring Conference
of the Union of Bulgarian Mathematicians
Pleven, April 6–10, 2016

STAGING OF SITUATIONS OF MAKING FINANCIAL DECISIONS AS A FORM OF INTRODUCING THEIR MATHEMATICAL BASES TO THE YOUTH*

Larisa Forkunova

Problem: The youth is one of the major segments of finance services users whose skills of correct financial behavior need formation. As a rule the young start the world almost from scratch and face complicated financial situations. Lack of knowledge or lack of skills required for choice of relevant mathematical methods in such situations as well as for performance of relevant calculations in the course of making decisions in such situations often results in drastic consequences.

Goal: Original methodology "Interactive Theatre of Financial Miniatures" is developed to familiarize the youth with mathematical methods of making best financial decisions in complicated financial situations.

Solution: This methodology represents an organizational-activity game which on the basis of actual examples allows to familiarize the pupils with notions of single-objective and multi-objective optimization problems and some ways of their solutions.

1. Introduction. Because of the economic problems caused by the world financial and economic crisis and unstable political situation in the world, the country's population is becoming more and more personally responsible for making financial decisions in the process of taking part in long-term savings, pension, insurance and mortgage programmes – both state-initiated ones and those suggested by different credit and insurance organizations. People's skills in making decisions still more and more determine not only their personal well-being at all stages of life cycle, but also stability of the economic development of our country.

However, according to the results of researches conducted in Russia, by the National Agency for Financial Studies (NAFS), in particular, many of our compatriots have heavy loan debts; they do not know how to file tax returns, choose pension plans, make cashless transfers, design business projects in order to start their own business; they have inflated expectations about the state support in case of financial losses, etc. All these problems result from a low level of people's financial literacy.

The notion of "financial literacy" is quite new in our national pedagogical science and teaching practice. The results of analysis of its historical development as a scientific category in Russia obtained by D. V. Moiseeva and I. A. Nebykov [1] show that this notion was introduced in 2008 by the specialists of the National Agency for Financial

*Key words: financial literacy, mathematical methods, multi-objective optimization problem, extracurricular activities.

Studies (NAFS), whom the World Bank commissioned to estimate the level or Russian people's financial literacy. The notion "financial literacy" was defined by the scientists as "the knowledge about financial institutions and products offered by them, as well as the ability to use them when needed and the understanding of consequences of one's own actions" [1, p. 165]. The scientific interpretation of this notion is developing nowadays under the influence of two tasks: 1) the operationalization of the notion with the purpose of theoretical justification of the suggested means and methods of diagnosing the level of people's financial literacy in our country; 2) the specification of the content and scope of the notion with the purpose of including it into the system of goals of the Russian continuous education system, defining the set of school subjects contributing to achieving this goal, and formulating requirements to the results of its accomplishment at each stage of education. It is in this second meaning that this notion is explained by the authors of the project "Contributing to increasing the level of people's financial literacy and developing financial education in the Russian Federation": "Financial literacy is the knowledge and understanding of financial notions and financial risks, as well as skills, motivation and confidence required for making effective decisions in different financial situations that contribute to improving financial well-being of a person and society, as well as developing the possibility to take part in the economic life [2].

2. Metodology. The basic statements of this conception are being implemented within the project of the World Bank and the Ministry of Finance of the Russian Federation "Contributing to increasing the level of people's financial literacy and developing financial education in the Russian Federation" that was started in 2011. At the moment the implementation of this project involves ten pilot regions, including the Arkhangelsk Region. The system of the project implementation events on the territory of the Arkhangelsk Region comprises educational programmes for all categories of population. NArFU named after M.V. Lomonosov as an institution of higher education specializes in preparation and implementation of programmes of increasing students and applicants' financial literacy (within the frames of occupational guidance events).

In this article we want to present the "Interactive Theatre of Financial Miniatures" as a form of occupational guidance work realized by volunteer students. The main advantage of the suggested form of work is not only the attraction of applicants into the university due to demonstrating scenes from student life to them, but also increasing the level of financial literacy of all categories of the interactive theatre participants (both spectators, i.e. applicants, and actors themselves, i.e. students).

Taking part in preparation of performances of the "Interactive Theatre of Financial Miniatures" involves students into activities of mathematical reasoning of financial decisions made by them in typical problem situations: planning a personal budget (rather small one as far as the majority of students is concerned), searching for sources of additional income (in the context of combining studying and working), creating and distributing common financial resources, etc.

Participation in acting a performance script out with subsequent analysis of mathematical bases of the made decisions demonstrates applicants the directions of development of their mathematical knowledge at the university, shows them a practical value of further mathematical education.

The performance consists of three miniatures: "Money! Quickly!", "The Job of My Dream", "My New Phone". A miniature is a scene from student life that is acted out

in front of spectators by students-"actors". Its purpose is to show spectators a problem situation that requires the performance characters to make an optimal financial decision from the point of view of the ordered set of criteria of a financial decision (situations of choosing a credit organization, a part-time job and a high-price item respectively).

The performance stops at the moment when the characters reach a deadlock. The actors suggest spectators getting involved and finding what they think to be the best way out of the problem situation. Then the performance goes on in order to demonstrate spectators the consequences of the made decision. If the made decision is not the best one, the characters are going to meet some difficulties, but if it is, the performance has a happy end.

What is of primary educational importance is the collective discussion of the made decisions after the miniature is over. At this stage the actors present spectators the problem situation as a task for the university course "Operational Research", get them acquainted with some mathematical methods of solving it (methods of solving single-objective and multi-objective optimization problems).

From the point of view of the pedagogical theory, the described form of work is a simplified model of an organizational-activity game (OAG). The notion of an OAG is connected with the thought and activity pedagogy (Y. V. Gromyko [3], P. G. Shchedrovitsky [4]).

Let us use the theoretical statements about an OAG in order to explain the mechanisms of appearance of the declared educational effects. Let us conduct the analysis of the suggested form of work as exemplified by the miniature "My New Phone".

An OAG is a complex multi-purpose system in which each category of its participants acts in accordance with its own goals but within the specific rules set by the authors for each stage. The correlation of the stages of an OAG and the "Interactive Theatre of Financial Miniatures" is shown in Table 1.

Stage 1. Preparation. The first stage of work involves volunteer students who create the performance script: they distribute roles, compose cues, select props, collect data through which the alternatives will be presented; there is also a university teacher who organizes and directs the students' activity. This stage also includes a test performance for a prearranged group of applicants. The role of such a group in the process of development of the presented game was played by the students – participants of the intramural round of the IV International Pedagogical Team Olympiade-Universiade that took place in MSU in 2015. This test allowed not only to obtain data required for improving the performance script, but also to find some typical mistakes in the students' financial behaviour which made it possible to correct the work of the team at all stages of the game.

1. Making financial decisions without any attempts to argue them. Despite the moderator's constant asking the question "***What*** *decision do you suggest and* ***why***?", on entering the game "active spectators" answered only the first part of the question that had to do with the alternative to be chosen. The second part of the question connected with the criteria of choice was lost sight of by them. Later in the performance, more often with the help of the "actors", the criteria of their choice were explained.

2. Making financial decisions in the absence of the understanding of variability of choice criteria and a possibility of doing things as based on a complex of criteria. In most cases one player used just one of the four criteria suggested in the performance and used by the "actors". Almost no "active spectators" suggested their own

Table 1. Stages of the game in terms of an OAG и and the "Interactive Theatre of Financial Miniatures"

OAG terms	**"Interactive Theatre of Financial Miniatures" terms**
Stage 1. Preparation	
1.1. Forming an OAG team. Goal setting, conception development.	Roles distribution. Creating a script.
Stage 2. Game	
2.1. Overview report.	Performance advertisement.
2.2. Involvement of the participants into the game.	Activity: – "spectators" watch miniperformances; – acting of the "actors" and the "active spectator".
2.3. Working of groups. Reflection.	Conversation with the spectators: – working with the "map of scripts"; – acquaintance with the mathematical methods of solving multi-objective optimization problems.
Stage 3. Reflection	
3.1. Summing up the results of the game.	Subsequent activities: – searching for a value system of a financially correct behaviour; – formulating requirements to the knowledge needed when making a difficult financial decision.

criteria, not mentioned in the process of staging the problem.

3. Making financial decisions just on the basis of the incomplete information about the product or service initially given by the shop assistant, employer or creditor, without independent searching for and estimating as much information as possible; absence of the understanding of antagonism of interests in such pairs as shop assistant-customer, employer-employee, creditor-borrower, etc. In spite of the fact that the "active spectators" when substituting "actors" of the performance were required to behave in a shop, bank or credit organization the way they would behave in real life, and that was announced by the moderator, almost no one used this opportunity.

Stage 2. Game. At the second stage we observe "realization in the form of a game of preliminarily designed and programmed working processes that yield products and results corresponding to the purposes of different players" [5].

2.1. During the overview report the players "explain the plot, main conception and the most important goals of the game" [5]. In our "theatre" this role is fulfilled by the moderator who announces the performance to the spectators, explaining the basic goals of the game in general and those of each of its stages, disclosing the game structure, describing the "spectators"' possible behaviour. The moderator's task is to attract the spectators' attention to the essence of the problem, get them to change their level of perception of the problem situation demonstrated in the performance.

2.2. Involvement of the participants into the game starts with acting the performance

out by the students-actors and "active spectators". The moderator at this substage manages the development of the game's plot: he or she describes the problem situation, stops the plot and gets it going again, chooses "active spectators", estimates consequences. The plot is built upon the following situation. Tanya once again broke her phone. Her friends, her fellow-students, suggest clubbing together and buying her a new phone for her birthday. They are to make a well-grounded choice of a phone brand out of four different variants (Fig. 1).

Fig. 1. Appearance of the slide with the alternative decisions within the miniperformance

In the process of discussion each of the girlfriends suggests the following criteria according to her view on the choice problem solution: low price, utility, shock resistance, style. Tanya takes all the suggested criteria, forms an ordered set out of them and puts it into words: "What's all this? We are supposed to select a cheap, high-utility, shock resistant, stylish smartphone? Are there such smartphones at all?" As Tanya does not know how to make a decision which would be the best one from the point of view of the given set of criteria the performance stops.

One of the "spectators" is asked to demonstrate their skills. Choosing such a spectator is turning them from a "passive spectator" into an "active spectator". On explaining what decision they choose and why (personal criterion/criteria of choice that may coincide with the criteria declared by the "actors" during the performance and may not) the "active spectator" substitutes Tanya, after which the performance is played to the end. So, at this stage of the game the "spectators" see the process of making a financial decision in the aspect of a set of alternatives and consequences of choosing one of them.

The further development of the performance is to get the "spectators" to give critical estimations of the actions and acting abilities of the brave person who dared to be an "active spectator". The purpose of this game is to forecast the consequences of choosing a particular alternative, estimate the correctness of the decision made by the "active

spectator" from the point of view of the criteria that determined his or her choice. The result of this estimation is the resolution to become an "active spectator" and play the situation again, make a critical remark towards another "active spectator", give them a piece of advice. So, at this stage the process of making a financial decision manifests itself in the aspect of the criteria of the best choice and the methods of their utilization.

2.3. At the stage "Conversation with the spectators" the game moderator helps to define what mathematical methods will be used to make the best financial decision. The moderator gives the spectators a "map of scripts" of the miniature which is a graph tree containing:

– all the criteria of the best choice stated in the script;
– all the possible ways of arranging the criteria of the best choice stated in the script;
– the best decisions corresponding to each ordered set of criteria (Fig. 2).

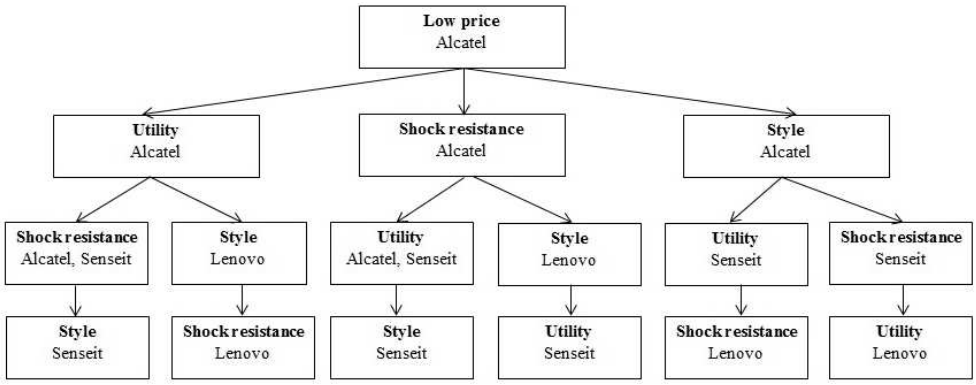

Fig. 2. Appearance of $\frac{1}{4}$ of the "map of scripts"

On the basis of this visualization a notion of a multi-objective optimization problem is introduced. The spectators are asked to remember not only the criteria on the basis of which the "actors" made their decisions, but the order of those criteria as well. On this ground a notion of a "choice criterion" is introduced, and the spectators get to know the way the chosen criteria are arranged depending on the current situation, a person's wish, etc.

Then the moderator suggests the spectators finding on the "map of scripts" the decision propounded by the "active spectators". Primary attention in this case is paid to the number of the choice criteria used when choosing an alternative, to the fact if the suggested criteria coincided with those suggested by the "actors" during the performance and if the procedure of arranging the criteria took place. The spectators are asked to find these solutions on the "map of scripts" if they are presented there or to construct the corresponding graph tree branch if they are not. In the process of completing this task the children come to a conclusion that they lack knowledge to say what decision should crown the constructed branch. After that on the basis of the analyzed examples the pupils consider in detail the additive method of solving multi-objective optimization problems used to construct a "tree of solutions". Let us take a closer look at the algorithm of building a "tree of solutions".

1. Composing a table of ratings for each product on the basis of the suggested criteria (Table 2). This table was made up on the basis of both the objective information about the items and the game developers' personal opinions.

Table 2. A table of ratings of alternative decisions existing in the performance and based on the choice criteria suggested there

	Rating for the criterion "Low price"	Rating for the criterion "Utility"	Rating for the criterion "Shock resistance"	Rating for the criterion "Style"
Alkatel	1	4	2	4
Senseit	2	3	1	3
Lenovo	3	1.5	3.5	2
iPhone	4	1.5	3.5	1
Total	10	10	10	10

2. Defining the value of particular criteria (Table 3).

Table 3. The value of particular criteria with regard to their order presented in the performance

Criterion	Rating of the criterion	Value of the criterion	Sign of the value of the criterion
1. Low price	1	0.4	C1
2. Utility	2	0.3	C2
3. Shock resistance	3	0.2	C3
4. Style	4	0.1	C4
Total	10	1	

3. Calculating the values of the objective function for all possible combinations of ratings (Fig. 3).

This example shows that at the end of the "tree of solutions" branch, corresponding to the choice criteria rating given in the performance (the far left branch in Fig. 2), there is a "Senseit" phone" solution, as for this the value of the objective function is minimum.

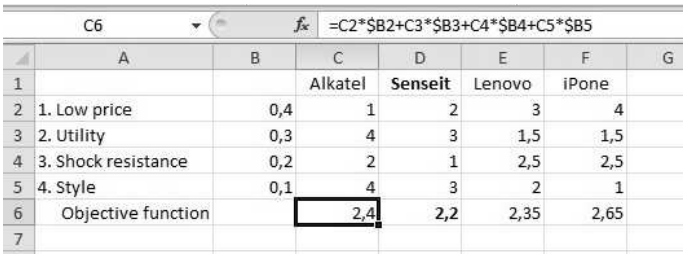

Fig. 3. Calculating the objective function for each item according to the situation of the performance

Stage 3. Reflection. "Aftereffect" is an educational discussion about the system of values to be guided by when estimating situations connected with making important financial decisions. In the process of the discussion the players put into words and repeat:

– possible finance management problems considered in the miniatures,

– the ways of their solution,

– personal responsibility for the consequences of decisions made in each of the presented situations,

– requirements to the knowledge needed to make a theoretically well-grounded financial decision.

This stage ends with formulating requirements to the knowledge a person needs to behave financially correctly in the situations under consideration.

3. Results. During the game the "moderator" gets the "spectators" through three stages of discussion (Table 4), including discussing activities and substantiating them.

Table 4. Levels of financial management discussion that are presented in the game

Stages	Level of discussion
Watching financial miniatures. Acting of an "active spectator".	The level of monetary operations.
Acquaintance with the mathematical methods of solving multi-objective optimization problems.	The level or arguing financial decisions.
Fixation of a system of the most important values of a financially correct behaviour.	The level of a system of values.

Thus, the participants of the performance gradually change their discussion level from simple financial management through realization and arguing of made decisions to understanding of responsibility for their consequences. This leads to realization of necessity of studying and implementation of mathematical methods in cases when complicated financial decisions are need to be made.

The offered methodology gives the opportunity to upper-form pupils and students to:

– get acquainted with notions "alternative decisions", "best decision", "one-objective optimization problem", "multi-objective optimization problem";

– learn certain mathematical methods of searching for the best decision of one-objective and multi-objective optimization problems;

– see in actual conditions the consequences of financial risks when made financial decisions are not the best ones;

– develop skills in financially correct behavior.

Testing of the performance "Interactive Theatre of Financial Miniatures" prepared by the 4th-year students of the "Pedagogical Education" programme (specialization: mathematics and IT) was carried out within the All-Russian week of financial literacy for children and youth – 2015. This event got the accompanying mathematics and economics teachers and supervisors keenly interested, and also showed that this form of work could be used to organize extracurricular activities at schools and conduct practical classes with university students. We see the further development of the idea of the "Interactive Theatre of Financial Miniatures" not only in creating new miniatures for different categories of spectators, but also in modifying the very model of an OAG: acting out a situation with multiple optimal choice from a fixed range of alternatives and with no predetermined choice.

4. Conclusion. The research carried out at the preparation stage of the offered above methodology highlighted typical mistakes in financial behavior of the youth. Basically these mistakes appear due to anticipation of the complicated financial situation as a

one-objective optimization problem. The young people make such decisions without elaborating, relying on the offered information mostly of promotional character or on the advices given by people around them.

Methodology developed by us on the basis of the acquired data allows the following:

- in situations most closely approximate to actual conditions it gives opportunity to pupil or student to see the consequences of poor decision;
- in the context of examples understandable by any young person it acquaints them with notion of multi-objective optimization problem and with certain mathematical methods of its solution comprehensible to general public;
- it prepares them to independent seeking of information (selection of alternatives and choice criteria), selection, learning and usage of relevant mathematical methods in other situations of making complicated financial decisions.

REFERENCES

[1] D. V. Moiseeva, I. A. Nebykov. Finansovaya gramotnost' naseleniya: k opredeleniyu ponyatij. Inzhenerno-stroitel'nyj vestnik Prikaspiya. **1**, No 44, Astrahanskij inzhenerno-stroitel'nyj institut, 2013, 164–168.

[2] The official site of the Russian Training Center of the Institute of Education of the National Research University "Higher School of Economics" `http://www.rtc-edu.ru/sites/default/files/files/news/doklad_finansovaya_gramotnost_rossiyskih_uchashchihsya.pdf` (Date of access: 08.11.2015).

[3] Y. V. Gromyko. Mysledeyatel'nostnaya pedagogika. M., Institut uchebnika "Paideia".

[4] G. P. Shchedrovickij. Organizacionno-deyatel'nostnaya igra kak novaya forma organizacii kollektivnoj mysledeyatel'nosti. Metody issledovaniya, diagnostiki i razvitiya mezhdunarodnyh trudovyh kollektivov. M., MNIIPU, 1983.

[5] G. P. Shchedrovickij. Organizacionno-deyatel'nostnaya igra kak novaya forma organizacii kollektivnoj mysledeyatel'nosti. `http://www.fondgp.ru/gp/biblio/rus/49/` (Date of access: 13.11.2015).

Larisa Forkunova
Institute of Mathematics, Information and Space Technologies
Department of Experimental Mathematics and Informatization of Education
Northern (Arctic) Federal University
Arkhangelsk, Russia
e-mail: `l.forkunova@narfu.ru`

ТЕАТРАЛИЗАЦИЯ СИТУАЦИЙ ПРИНЯТИЯ ФИНАНСОВЫХ РЕШЕНИЙ КАК ФОРМА ОЗНАКОМЛЕНИЯ МОЛОДЕЖИ С ИХ МАТЕМАТИЧЕСКИМИ ОСНОВАМИ

Лариса Форкунова

Проблема: Молодежь является одним из наиболее значимых сегментов пользователей финансовых услуг нуждающихся в формировании навыков грамотного финансового поведения. Начиная самостоятельную жизнь зачастую практически с нуля, молодые люди попадают в сложные финансовые ситуации. Незнание или неумение выбирать подходящий ситуации математический аппарат, проводить необходимые вычисления при принятии решения в таких ситуациях может привести к тяжелым последствиям.

Цель: На знакомство молодежи с математическими методами принятия оптимальных решений в сложных финансовых ситуациях направлена форма работы, названная нами „Интерактивный театр финансовых миниатюр“.

Решение: Эта форма работы представляет собой огранизационно-деятельностную игру (ОДИ), которая позволяет на конкретных примерах познакомить молодых людей с понятиями многокритериальной и однокритериальной задач оптимизации, некоторыми способами их решения.