The Theory of Catastrophes as a Model of Learning

Rajabov Komil Askarovich
Candidate of Pedagogical Sciences, Associate Professor of the Fergana Polytechnic Institute, Fergana, Uzbekistan

ABSTRACT

An attempt was made to create a mathematical model by reproducing new knowledge or previously mastered knowledge in order to group students' knowledge using the theory of destruction.

Keywords: Knowledge, grouping, destruction, theory, repetition, student, goal, model.

Introduction

Consider in the article some abstract knowledge base, that is, a system for storing, transforming and generating information that functions in interaction with the environment. The dynamics of the knowledge base act for us as a model for the student in the learning system [1-3].

Schematically, the knowledge base can be characterized by the number X - elements of the knowledge base, which are presented in the base, abstracting, of course, from their qualitative features. Let us assume that the change in X is caused by the processes of generation and forgetting, the rates of which depend on the value of X, that is, let us assume that the dynamics of the base is described by an equation of the form:

$$\frac{dx}{dt} = \left(b + \varphi(x)\right) \cdot x - a \qquad (1)$$

where a - characterizes the process of forgetting, b - generation, and the non-linear term φ(x) will be interpreted as describing the process of combining elements of the knowledge base [4-9].

Let us assume that on I element of the knowledge base that entered the base, the rate of formation of associations of elements is proportional to the square of X, that is

$$\frac{dx}{dt} = \left(b - d \cdot x^2\right) x - a \qquad (2)$$

Or, gently $d \equiv 1$

We have

$$\frac{dx}{dt} = -x^3 + bx - a \qquad (3)$$

The cubic term is analogous to the term containing the product
concentrations of reacting elements in an equation describing the rate of a chemical reaction involving three components. In our case, one of the three associated elements is the role of a “stimulus”, a link for the formation of an association between two disparate ones [10-14].

Thus, the cubic term on the right side (I) is responsible for the consolidation of knowledge base units, and the linear one is responsible for their quantitative growth.

We will be interested in the influence of the parameters *a,* and *b* on the stationary state of the equation. It is known that the stationary state is surrounded by some attraction regions, and it is essential to know whether small changes in the system parameters will lead to a shift from one attraction region to another, which, in turn, can lead to sharp qualitative changes in the further behaviour of the system [14-16].

In the elementary theory of catastrophes, it is assumed that the behaviour of the process under study is controlled by some potential function, the local minima of which correspond to equilibrium states. In this case, it is often not important to know the function; it is enough to recognize the fact of its existence. We will assume that the equilibrium states are established faster than the process proceeds, and we will study the influence of the input parameters of systems a and b on the output value, which is taken as the stationary value x_{CT}, that is, the value of X corresponding to the minimum of the potential function

$$F(x,a,b)=\frac{-x^4}{4}+\frac{(bx^2)}{2}-ax \qquad (4)$$

The stationary point of this function is found from the condition:

$$\frac{dF}{dx}=-x^3+bx-a \qquad (5)$$

equality to zero of the left side of the equation of dynamics of the knowledge base. The resulting cubic equation $\boldsymbol{x^3 - bx + a = 0}$ has roots that are calculated by the Cardano formulas, and the nature of the roots is determined by the sign of the discriminant:

$$\boldsymbol{D}=-\frac{\boldsymbol{b}^3}{27}+\frac{\boldsymbol{a}^2}{4} \qquad (6)$$

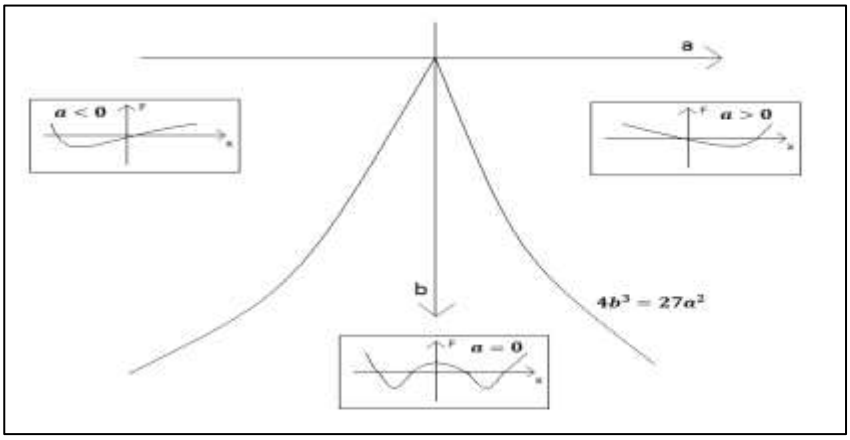
If - all roots are real, different;$D < 0$

$D = 0$- all roots are real, of which at least two are equal;

$D > 0$- one real root and two complex ones.

If $D < 0 > 0$, then condition b$>$ 0 must be satisfied, which corresponds to a positive base change rate for each incoming knowledge base element.

The dependence of the potential function F(x, a, b) on the parameters has the following character, disclosed in the graph (Fig. 1).



Picture 1.

Outside the curve in the plane, the function has one minimum (one steady state), and inside - two minima and one maximum. The curve D=0, which separates the regions where one and two stable states are located, is called the bifurcation curve $4b^3 = 27a^2$.

If in space we build the dependence of the position of stationary points on the parameters *a,* and *b*, then we get a picture (Fig. 2).

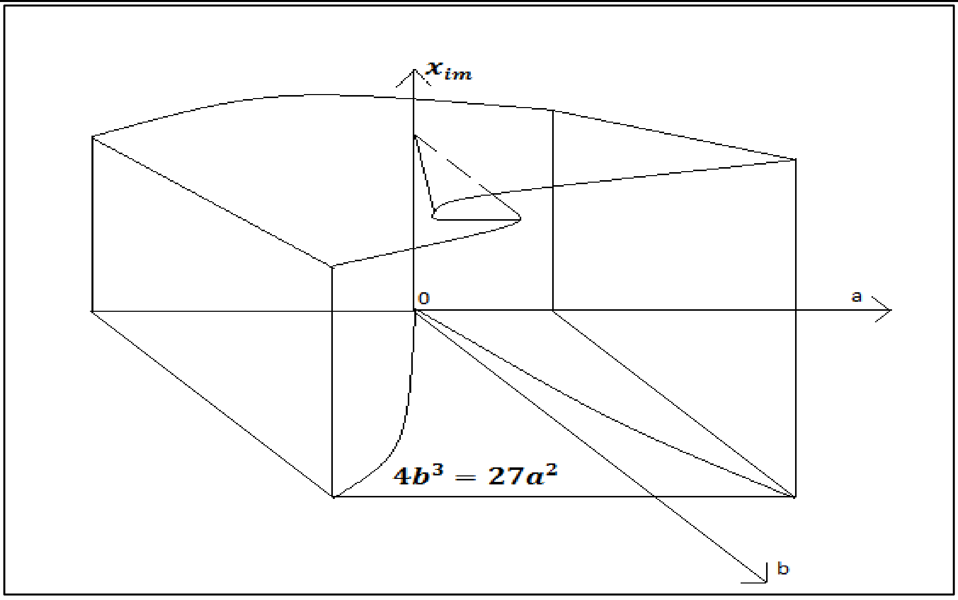


Figure 2.

At the points of the surface where there is a vertical tangent through the inflexion point, two stationary modes merge. The projection of these points is a bifurcation curve $x_{im} = x_{im}(a, b)$.

The presented surface does not depict processes in the knowledge base, but only the dependence of stationary states on parameters. To describe the process, assumptions are needed about the dependence of the system parameters in the form:

$$\begin{aligned} a &= a(x,t); \\ b &= b(x,t) \end{aligned} \quad (7)$$

Or

$$\begin{aligned} \frac{da}{dt} &= \alpha(a,x,t); \\ \frac{db}{dt} &= \beta(b,x,t) \end{aligned} \quad (8)$$

However, several general qualitative properties can be obtained in the dynamics of the system, without resorting to the study of specific types of function, using the methods of elementary catastrophe theory.$a(x,t)b(x,t)$

The considered dependence refers to one of the seven elementary catastrophes and is called the “assembly” catastrophe. It has a number of features that directly allow us to give a psychological interpretation of the considered model of the knowledge base.

In the region lying inside the bifurcation curve, the system corresponds to two states for the same values of the parameters. In addition, there are X values at which the system cannot be, and the transition between states is carried out abruptly.

Two system instances with the same parameter values move to different build levels. The noted qualitative characteristics of the model, discovered by methods of analysis of the structural stability of the differential equation (I), allow us to draw similar conclusions in terms of characterizing the student's behaviour in the learning system. Learning takes place in leaps as a result of the action of two opposite trends in the accumulation of knowledge - an increase in the number of fragmented knowledge, consolidation of units and the formation of associations. The success of learning can be different for people with the same abilities due to minor influences of random associations and other factors. The model explains the positive role of "forgetting" in the generation of knowledge, and such substantiates well-known recommendations on the nature of repetition. Time-dispersed repetition is more effective than concentrated repetition, since the same element of knowledge finds the base in its various states, due to the “forgetting” processes implemented in it. Naturally, this recommendation is of limited use, since along with the forgotten "incorrect" associations and elements in the database, "correct" ones can also disappear. Repetition through a variety of activities carried out with a certain reconstruction of the material, such is more effective than simple repetition, as it increases the likelihood of new associations, therefore, jumps. The presentation of material by immediately connected enlarged units is more efficient in terms of initializing additional connections and associations and, therefore, abrupt changes in the student's knowledge. For the purposes of further research,

The computer form of education is characterized by the fact that, within the framework of this form, the student carries out experiments with some information environment of an imitation-game computational nature. Thus, in its essence, such a form is opposite to generalized knowledge formulated in the framework of the theoretical development of reality. Private acts obtained as a result of individual work on a computer, in this case, can initiate new connections, and contribute to the formation of ideas and hypotheses if they introduce new connecting stimulating links into the student's knowledge.

A positive element here can be obtained by using not separate training programs, but complex simulation-game and computational experimental works that form a well-thought-out chain of training activities related in a special way to the main course. The effectiveness of such an "accompanying" course of computer learning is similar to the role of laboratory experiments in the disciplines of the natural cycle. The effect of influence on learning is determined by the fact that particular facts become the foundations of true generalizing constructions.

References

1. Alimjonova, G. (2021). Modern competencies in the techno-culture of future technical specialists. *Current research journal of pedagogics*, *2*(06), 78-84.
2. Ahmadjanovich, U. A., Ismoiljonovich, F. J., & Sodiqovna, U. M. (2022). The Importance Of The Maple System In The Development Of Professional Competence Of Students Of Technical Higher Education Institutions. *Eurasian Journal of Learning and Academic Teaching*, *10*, 33-36.
3. Alimjonova, G. (2021). The need for integration of social and technical knowledge in the development of technological culture of students of higher technical educational institutions. *ACADEMICIA: An International Multidisciplinary Research Journal*, *11*(3), 502-510.
4. Вахобов, М. М. (2016). Компетенциявий ёндашувга асосланган давлат таълим стандартларини жорий этиш–замонавий таълим парадигмаси сифатида. *Современное образование (Узбекистан)*, (10), 3-10.
5. Иноятов, У. И., Муслимов, Н. А., ДИ, Р., & Усмонбоева, М. Ҳ. (2016). Педагогика (нопедагогик олий таълим муассасалари учун дарслик). *Тошкент: Низомий номидаги ТДПУ*, *256*.
6. Mirzakarimov, E. M., & Faizullaev, J. I. (2019). Method of teaching the integration of information and educational technologies in a heterogeneous parabolic equation. *scientific bulletin of namangan state university*, *1*(5), 13-17.
7. Nazarova, G. (2021). Methods of directing economics to scientific research activities. *Current research journal of pedagogics*, *2*(06), 90-95.
8. Темуров, С. Й. (2014). Бўлажак математика ўқитувчиларида касбий компетентликни шакллантиришнинг назарий асослари. *Т.“Фан ва технология*.
9. Fayzullaev, J. (2020). A systematic approach to the development of mathematical competence among students of technical universities. *European Journal of Research and Reflection in Educational Sciences Vol*, *8*(3), 42-47.
10. Fayzullayev, J. I. (2020). Mathematical competence development method for students through solving the vibration problem with a maple system. *Scientific bulletin of Namangan state university*, *2*(8), 353-358.

11. Фундаментал фанлар ёрдамида техника олий таълим муассасалари талабаларининг касбий компетентлигини ривожлантириш, *Oriental renaissance: Innovative, educational, natural and social sciences*, 10-457-461.
12. Файзуллаев, Ж. И. (2022). Математик билимлар орқали техника олий таълим муассасалари талабаларининг интелектуал қобилиятларини ривожлантириш. *Central Asian Academic Journal of Scientific Research*, *2*(5), 255-260.
13. https://expeducation.ru/ru/article/view?id=10351
14. https://www.src-master.ru/article25985.html
15. https://esgi-miet.ru/ekonomika-innovatsionnogo-razvitiya-teoriya-i-praktika/teoriya-katastrof-kak-metodologicheskaya-osnova-ekonomicheskikh-otsenok-proektov-mega-klassa
16. http://math.phys.msu.ru/Education/Special_courses/Catastrophe_theory_and_its_applications_in_physics/show_page