RESOLVING PARADOXES OF PHYSICS IN THE UNIVERSITY STUDY

DJIDJIAN ROBERT,

Armenian State Pedagogical University after Kh. Abovyan, Yerevan, Armenia

E -mail:r.djidjian@gmail.com

GEVORGYAN MARIAM,

French University in Armenia, Yerevan, Armenia. Institute for Physical Research, NAS

E -mail:mariamgevorgyan89@gmail.com

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ABSTRACT

The article substantiates the thesis about the futility of the usual interpretation of creativity as originality. In order to make our position on this issue more convincing, we have given to the originality concept an appearance of contradiction. The discussion in the article leads to the conclusion thatthe category of creative thinking will be really effective if the main characteristic of the creativity were not originality but rather the ability to *independent* problem solving. The article presents the optimal steps for an independent solution of research problems. Authors introduce the idea of "easy paradoxes" for developing creative thinking.

Keywords: *main concepts of quantum mechanics, paradoxes of quantum mechanics, creativity, originality of the solution, ability to think independently.*

INTRODUCTION

Innovative ideas occupy an important place in the processes determining modern social progress. According to modern perception, the characteristic feature of innovation is that the innovative product enjoys extraordinary demand. From that characteristic

follows the second important aspect of innovative ideas, that of being extremely profitable. It is time to realize that the young generation needs to be educated on innovation. Indeed, the best investment is the education of the younger generation.An old Chinese proverb teaches us: "If you plan for a year, sow rice. If you plan for a decade, plant trees. If you plan for life, educate people."

It is rightly emphasized that the basis of innovative thinking is independent thinking. The ability to think independently is formed thanks to the rich experience of solving school problems. Indeed, if a student is able to solve problems for which there is no algorithmic way of solving them, then his thinking is independent and, to that same extent, innovative.

We all know many impressive cases of innovative thought. Among them are the steam engine (James White), the airplane (Wright brothers), electric lighting (Thomas Edison), the telephone (Alexander Graham Bell), color television (Petros Adamyan), and others.

Non-standard solutions to problems, new ideas, creative thinking, and innovative approaches are important in successful education. It is very important, however, to maintain a balance between innovation and common sense, to be able to show originality.

METHODOLOGY

Hierarchy of levels of thinking

Nowadays, innovative thinking is considered the crown bearer of human thinking. In the last century, that title was held by creative thinking. The paradoxes of innovative and creative thinking presented in this article force us to admit that the crowning glory of human thinking is the ability to think independently. The cornerstones of independent thinking are analytical thinking [5] and the ability to generate ideas(Gordon F.S., 1961; OsbornA. F.,1976). The effective solution to problems is carried out in two stages. *analysis* of the researched problem and *synthesis* (generation) of the idea of solving the researched problem.

The first of these two stages is carried out in a clear sequence of steps.

The analysis of the problem under research is performed by the following steps:

- Understand the text of the problem.

- ➢ Determine the topic of theproblem.
- ➢ Separate the main data from the secondary.
- ➢ Make the necessary conclusions from the data of the problem.
- ➢ Divide the problem into a set of sub-problems.
- ➢ Make a schematic diagram of the investigated problem.
- ➢ Clearly fix and record the structure of the problem.
- ➢ Include knowledge and information relevant to the problem at each step of problem analysis (Djidjian R.,2004).

Synthesis (generation) of the idea of solving the researched problem

The idea of a possible solution to each issue (problem) is put forward by a similar idea of the solution of some "prototype" problem (Djidjian R.,2002;Djidjian R.,2004). Even the sages of the ancient world recorded that nothing can come from nothing in the material world. This principle is also fully extended to the world of knowledge. In ancient times, the mind of a young child was likened to a clean slate (*tabula rasa*), on which the child's experience, and above all his learning, record everyday knowledge and basics of scientific knowledge. An individual's stock of knowledge, mainly a set of solved problems, is the source from which new ideas arise in the individual's thinking. Every new solution is brought forward by analogy with the idea of a solution to some prototype problem. This truth is reflected in a well-known proverb: a new idea is actually an old well forgotten one. It remains to add that the old solution leads to the new solution through the bridge of similarity.

One can also apply PARLA /problem, action, results, learned application technique for teaching students the possible solutions of paradoxes, which answers to the following question: What was the situation or the problem? What did you do in this situation? Based on the problem and what did you do? What did you gain or learn from the experience? How does this example apply to the organization?

The paradoxes of creative thinking

Generations of students are the most important foundation for innovation. As their thinking improves, the effectiveness and productivity of innovations in education will steadily increase.

Over the past decades, the emerging trends of globalization and international cooperation based on a common educational environment have caused significant changes in the field of educational organization principles. The traditional education system focused mainly on the acquisition of knowledge to form general and professional erudition. Meanwhile, the modern education system should be focused on the creation of a cognitive algorithm, critical understanding, forming research skills, and willingness to innovate. At the same time, interactive and participatory education is brought to the fore as a basis for creating an educational environment for the new generation of students ((Lipai T. P. &Gevorgyan M. R.,2021).

Having the first, fundamental role of information technologies for the innovative education of the new generation of students and improving their impact, along with the expansion of existing tools, will continue to work to increase the effectiveness of innovations in education(Lipai T. P. &Gevorgyan M. R.,2021; OsbornA. F.,1976).

Growing and developing science is accompanied by contradictions of various nature(Djidjian R.Z. & Gevorgyan M.R. (2021;Gevorgyan M.R.(2014).

Paradox 1: Today, there are various organizations that promise their clients that within two to three months, they will increase and strengthen the level and power of creative thinking of their beneficiaries. However, in the practical training of these organizations, there is a complete absence of exercises that strengthen the uniqueness of the client's solutions. No specialist in the development of creative thinking has ever tried to show how it is possible to get a unique solution instead of a known solution to any problem. This fact proves that every specialist realizes that the *originality of problem solving cannot be ensured*. Whether a solution to a serious scientific or technological problem is original or non-original becomes clear only after solving the problem. The main thing for a research scientist is to solve a given problem, and no one will blame him if his solution is not original.

Corollary 1: Paradox1 reveals that interpreting creativity as originality is a fruitless, unimportant meaning. Let's call the meaning of creativity as originality a narrow meaning and record that it has no practical value.

Contradiction 2: If we consider the unlikely possibility that advocates of creative thinking would abandon the popular interpretation of the originality of solving a problem, then it would mean abandoning the popular idea in the field of scientific research that a creative solution, first of all, presupposes the originality of that solution.

Corollary 2: The contradiction revealed by Paradox 2 means that the term creativity in the field of scientific inquiry is either not applicable in the narrow sense of originality, or it is an incidental characteristic that is not considered at all in research.

Paradox 3: It is not difficult to prove that at the level of existing knowledge, a new idea can be presented only by analogy *(see Theorem 1).*

Theorem 1: Any new idea can be proposed only by analogy.

Evidence: Indeed, the ways of thinking are divided into two types: necessary inferences and probable inferences. Moreover, two subtypes are distinguished in necessary inferences: deduction and complete induction. The deduction is done by extending some general judgment (axiom or principle) to a specific case. It is clear that no new knowledge can be obtained by extending a general principle to a case involved in that principle. Complete induction, revealing that *every* object in the group being examined has the property in question, concludes that *all* objects in the group have the property in question. Obviously, by replacing the term "each" with the term "all", we do not gain new knowledge again.

Let's move on to probable inferences, which also come in two subtypes: incomplete induction and inference by analogy. Non-complete induction, finding that some number of objects in the group under investigation have the property in question, concludes that all objects in the group have the property in question. With such a generalization, if confirmed, the researcher does gain new knowledge, but what is gained means only a quantitative increase.

What remains is the *analogy*, which, on the basis of the similarity between two objects, assumes that if one of them has the property under discussion, it is likely that this property is also present in the second object. Such an assumption made by analogy, if confirmed, means the acquisition of qualitatively new knowledge.

Thus, we have proved Theorem 1: new knowledge is gained only through analogy.

The following important conclusion follows from Theorem 1. Great innovative ideas are discovered only through remote analogies, quite often, through very remote analogies. Realizing and understanding this important conclusion, we find ourselves faced with serious difficulty. The field of remote similarities is endless, and these remote similarities are weak similarities. In what direction, at what approximate distance, should one look for the unknown similarity containing the idea of the given great discovery? From such a clear formulation of the question, it is quite clear that the methodology cannot and never will be able to offer any useful advice on how to detect the remote similarity that contains the idea of a great discovery.

But famous scientists have made great discoveries, haven't they? How did brilliant scientists make their discoveries? It is clear from our discussion that all great theoretical discoveries were made by accident. In the endless field of distant resemblances, a distant resemblance containing the idea of a great discovery can be noticed only by chance.

The remote similarity which contains the idea of that accidental great discovery can only be realized by the scientist who is searching for the solution of the corresponding problem. This is where geniuses of science have an advantage. They are capable of devoting their entire conscious life to the research of a question that interests them (Djidjian R.,2002).

Paradoxes of quantum mechanics for activating students' interest toward physics

Until today, the logic of human thinking was mainly developed as the theory of proof and argumentation. And because the immediate subject of that theory were the forms of thought, then starting with the great Aristotle, the logical monographs and textbooks based on that approach were also focused on the formal side of thinking, overshadowing the goals and problems of scientific research and creative thought.

We consider it worth noting that Aristotelian logical inheritance, especially his *Topica*, also included embryos of theory of scientific research (Aristotle,2018). At the beginning of the 17th century, the great English thinker Francis Bacon published a very pretentious work *New Organon,* contrasting his method of true induction with contrasting his method of "true induction" with the deductive method of Aristotle's

deductive method. Bacon believed that his inductive method will provide human race discoveries and inventions (Bacon F.,1978). Rene Descartes, French famous mathematician, physicist, and philosopher of the same 17th century, contributed significantly to solving the problem of creating new logic, by writing the valuable works "*An essay on method*" and "*Rules for the Direction of the Mind*". The movement to create research logic was further developed by the 19th century famous English methodologists William Whevell, John Herschel and John Stewart Mill. Due to their research and publications, the method of hypothesis was actually affirmed as the universal method of scientific research(Descartes R.,1989, Mill D.S.,1914). Under the influence of results and achievements of English methodologists, the logic textbooks have introduced radically new sections, covering the inductive method for discovering causes of natural phenomena leading from the particular facts to the general logical conclusions and elucidating the role of hypothetical reasoning in the process of scientific research and discoveries.

From the point of view of the general method of scientific knowledge, a valuable study was made by Ernst Mach, a famous Austrian philosopher of the beginning of the 20th century, in his interesting book "Knowledge and Error" (Max, 1909). Austrian philosopher Karl Popper gained great fame thanks to the book he published with the promising and responsible title "Logic of Scientific Discoveries", in which, however, he limited himself to a brief statement that the logic of discoveries cannot be created (Popper K.R.,1968).

Quite independently of the mentioned direction leading to the logic of scientific research, in the second half of the 20th century, three brilliant authors appeared in the United States with their publications: Alex Osborne, William Gordon and George Poya. Their ideas are certainly important from the point of view of developing theory of creative thinking (Gordon F.S.,1961; Poya D.,1970). The mentioned works gave a new momentum to the new publications on creative thinking, however, they did not set the task of developing a general theory.

Scientific research begins with a question that interests the given scientist either because the answer is not yet known (and the question seems important to the scientist),

or because the accepted answer to that question does not satisfy him. In fact, the process of choosing a research problem is somewhat elementary in nature. First, the research problem is often directly presented to the young scientist by his scientific supervisor. On the other hand, a scientist in his life and activities on one occasion or another encounters various unsolved problems, gets acquainted with opinions and approaches to solving them to varying degrees.

The derivation of necessary consequences is a clear-cut process, and scientists do not have any principle difficulties with it. On the other hand, scientific problems are usually presented to researchers in a "ready-made" form. These two circumstances show that the central problem of the hypothesis method is the proposition of hypotheses. The basis for the formulation of hypotheses is the analysis of the problem, and the immediate means is the synthesis of the idea of the solution, similar to the idea of the solution of the prototype problem.

Perhaps every specialist in the field of education today realizes that the main goal and task of education in the current phase of informational revolution is to develop students' independent thinking. However, until university faculty members have a clear idea of what is the logical structure and components of independent thinking, its general method and specific steps, it will be quite difficult to achieve this goal, and the efforts will be ineffective.

CONCLUSION

Paradoxes are presented as factors that strongly strengthen the interest of students. This is especially true for the most impressive classical paradoxes and the indifference of scientists to the paradoxes of physics.

In order to make our words on this issue more impressive, we have given the two important circumstances mentioned above the appearance of a paradox, a contradiction. The discussion in the article leads to the conclusion that the category of creative thinking will be really effective if the main characteristic of the creative is not originality, but the ability to independently explore and solve problems.

The article presents the optimal steps for independent investigation and solution of research problems.

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РЕЗЮМЕ

РАЗРЕШЕНИЕ ПАРАДОКСОВ ФИЗИКИ В УНИВЕРСИТЕТСКОЙ ОБУЧЕНИИ

ДЖИДЖЯН РОБЕРТ, ГЕВОРГЯН МАРИАМ

В статье обосновывается тезис о бесплодности привычной трактовки творчества как оригинальности. Прежде всего следует учитывать, что ни один

ученый никогда не ставит перед собой цель, чтобы решение исследуемой им проблемы было обязательно оригинальным. С другой стороны, специалисты, ведущие размещенные в Интернете многочисленные сайты, обещающие развитие творческого мышления, никогда не заявляют, что любой, кто освоил их курс, может оригинально решить любую проблему. Для того чтобы наши слова были в этом вопросе более впечатляющими, мы придали двум указанным выше важным обстоятельствам вид парадокса, противоречия. Обсуждение в статье приводит к выводу, что категория творческое мышление будет действительно эффективным, если главной характеристикой творческого будет не оригинальность, а способность самостоятельно исследовать и решать проблемы. В статье представлены оптимальные шаги для самостоятельного решения исследовательских задач.

Ключевые слова: *основных понятий квантовой механики, парадоксы квантовой механики, креативность, оригинальность решения, способность самостоятельного мышления.*

ԱՄՓՈՓՈՒՄ

ՖԻԶԻԿԱՅԻ ՊԱՐԱԴՈՔՍՆԵՐԻ ԼՈՒԾՈՒՄԸ ՀԱՄԱԼՍԱՐԱՆԱԿԱՆ ԴԱՍԸՆԹԱՑՈՒՄ

ՋԻՋՅԱՆ ՌՈԲԵՐՏ, ԳԵՎՈՐԳՅԱՆ ՄԱՐԻԱՄ

Հոդվածում հիմնավորվում է ստեղծագործ մտածելակերպը՝ որպես ինքնատիպության մեկնաբանության մասին թեզ: Նախ, պետք է նկատի ունենալ, որ ոչ մի գիտնական երբեք իր առջև նպատակ չի դնում, որ իր ուսումնասիրած խնդրի լուծումը պարտադիր օրիգինալ լինի: Այս հարցի շուրջ մեր խոսքն ավելի տպավորիչ դարձնելու համար վերը նշված երկու կարևոր հանգամանքներին պարադոքսի, հակասության տեսք ենք տվել: Հոդվածում քննարկումը հանգեցնում է այն եզրակացության, որ ստեղծագործ մտածողության կատեգորիան իսկապես արդյունավետ կլինի, եթե ստեղծագործողի հիմնական հատկանիշը ոչ թե ինքնատիպությունը լինի, այլ խնդրի ինքնուրույն ուսումնասիրումն ու լուծումը: Հոդվածում ներկայացված են հետազոտական խնդիրների ինքնուրույն լուծման օպտիմալ քայլերը:

Հոդվածի նպատակն է առաջադրել քվանտային մեխանիկայի հիմնական պարադոքսների հնարավոր լուծուման տարբերակներ:

Ներկայացված են մոտեցումներ՝ բուհական դասընթացում ուսանողների քվանտային մեխանիկայի հիմնական հասկացությունների կիրառմամբ՝ միտված հիմնական պարադոքսների հնարավոր լուծումների յուրացմանը:

Բանալի բառեր՝ քվանտային մեխանիկայի հիմնական հասկացություններ, քվանտային մեխանիկայի պարադոքսներ, ստեղծագործ մտածելակերպ, լուծման ինքնատիպություն, ինքնուրույն մտածողության կարողություն:

Հոդվածը սրացվել է՝ 04.04.2023

Հոդվածն ուղարկվել է գրախոսման՝ 08.04.2023

Հոդվածը երաշխավորվել է տպագրության՝ 12.07.2023