

The Value of Mathematical Creativity and Innovation in Entrepreneurship

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Abstract

All innovation begins with mathematical creative ideas. Creativity is the starting point for innovation. It has been traditionally attributed to art and Literature but now- a- days doing science has also been considered as a creative act. Mathematical Creativity is however necessary but not sufficient condition for innovation. Innovation is the implantation of creative inspiration. The main focus of this paper is to provide an overview of definitions and characteristics of mathematical creativity based on innovation in entrepreneurship. This paper will discuss and describe the essence of mathematical creativity and innovation in entrepreneurship.

Key Words: Innovation, Creativity, Inspiration, Mathematical.

Introduction

Drucker (1985) argued that innovation is the tool of entrepreneurship. In addition, both innovation and entrepreneurship demand mathematical creativity. Mathematical Creativity is the ability to make or otherwise bring into existences something new, whether a new solution to a problem, a new method or device, or a new artistic object or form. Wyckoff (1991) defines creativity as new and useful. Creativity is the act of seeing things that everyone around us sees while making connections that no one else has made. Mathematical Creativity is moving from the known to the unknown.

No entrepreneur or enterprise, however successful and big, can continue to hold a place of leadership unless it recognizes that modern business operates in a world of galloping change

which creates new problems, risk and opportunities and for which they have to mobilize the enterprise's resources before changes make their impact felt. To do successfully, the entrepreneur and enterprise should know where this firm is going and how the firm will get there. Here, we need mathematical creativity. This in turn requires a clear definition of the company's business which will enable it to continually adapt operations to the realities of the market place, 'the very corner stone of survival and growth' Innovation is nothing but adding something new to an existing product or process. The product or process has already been created from scratch and has worked reasonably well. When it is changed so that it works better or fulfils a different need, then there is innovation on what already exists. Hence Mathematical creativity Innovation are the successful exploitation of new ideas.

Creative Thinking

Creative thinking has various definitions (Okpara 2000). However, it is the art of generating solution to problems by the force of imagination and reasoning. It is an activity of the mind seeking to find answer to some of life's questions. In a dynamic and changing world, the challenges of man are also not static. They take on new forms and require a deep creative thinking approach. Creative Thinking can be considered as a dynamic mental process including convergent and divergent thinking.

Every idea is a product of thinking and every product is the manifestation of idea naked in a thinker's mind. These are people who see problems as opportunities to improve and do something new or something better, people who keep these two vital questions on their mind. "What can I do to make things better, or what can I do to make better things? This is the product of thinking.

In making things better, the goals are usually to improve productivity and efficiency, achieve speed, enhanced comfort and convenience, influence returns positively, and so much more. While in making better things, thinking can produce various alternative leading making better things, thinking can produce various alternative leading to the evolution of a completely

Engineering & Technology in India www.engineeringandtechnologyinindia.com

ISSN 2472-8640 1:5 December 2016

Dr. C. Swarnalatha, Ph.D. (Ed.) Entrepreneurship and Management:

Innovative Construction Techniques and Ecological Development. Vol. 2 Civil Engineering

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new idea, new production processes, or a total departure from the conventional. Whatever the goal, thinking is an indispensable tool in the life of all successful entrepreneurs.

The celebrated discoveries of man are not accidents. The minds of men/women were engaged in creative thinking to deliver the visible products we enjoy today. Name them: Bill Gate and the computer, Graham Bell and the telephone, Michael Faraday and electricity, Isaac Newton and physical law of science, the Wright brothers and Aeroplane, Adenuga and Consolidated oil, Atedo peterside and Investment Banking and Trust Company, Raymond Depokesi and Dear Communications. The list is endless. You too can join them as you begin to “ponder the path of your feet, that all your ways may be established.”

Thinking begins with engaging yourself in a conversation with yourself by yourself, in yourself. That is to reach a conviction and conclusion as to what steps to take and what strategies to employ in a situation. The place of asking the right and relevant questions in thinking process cannot be overemphasized. Questions remain the string tool to provoke the mind to respond to issues and discover new things. Creative thinking must, therefore, lead to the articulation of a strategy. It is a common knowledge that successful entrepreneurs emerge not by strength or force but by superior strategy through creative thinking.

There are great business opportunities in applying creative thinking to solving mankind’s crying need for basic products and basic support services –better homes, better jobs, and a better way of life. However, being able to adapt ideas is what makes an entrepreneur successful. There is nothing wrong with learning from others ideas. Creativity comes in when you expand upon it, when you take an idea and make it move.

Mathematical Creativity

Mathematical creativity is the ability to generate new ideas by combining, changing, or reapplying existing ideas. Some creative ideas are astonishing and brilliant, while others are just simple, good practical ideas that no one seems to have thought, of yet. (Harris,

Engineering & Technology in India www.engineeringandtechnologyinindia.com

ISSN 2472-8640 1:5 December 2016

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1998). Creativity in mathematics helps us make sense of the world. However, in typical classrooms, we are taught as mathematics is all about rules and procedures. We should see how mathematics was developed and realize that creative individuals shaped the body of mathematical knowledge. More emphasis should be placed on creative ways of expressing ideas.

In this information and communication technology age, creative and skilled manpower are needed to support the vision of our nation. An emerging technological society and economy makes mathematical knowledge and creativity both essential and advantageous for us to join the workforce.

Mathematics relies on logic and creativity, and it is pursued both for a variety of practical purposes and for its intrinsic interest. The essence of mathematics lies in its beauty and its intellectual challenge. Learning to know our creativity ability is one of the most significant aspects of our life, for everything we do, is affected by our thinking abilities.

A product is creative when it is “novel” and “appropriate”. A novel product is original, not predictable. The bigger the concept, and the more the product stimulates further work ideals, the more the product is creative (Stermering and Lubart). Mathematical Creativity requires passion and commitment. Out of the creative is born symbols and myths. It brings to our awareness what was previously hidden and points to new life.

The Principles of Mathematical Creativity

Ervynck (1991) described mathematical creativity in terms of three stages. The first stage (Stage 0) is referred to as the *preliminary technical stage*, which consists of "some kind of technical or practical application of mathematical rules and procedures, without the user having any awareness of the theoretical foundation" (p. 42). The second stage (Stage 1) is that of *algorithmic activity*, which consists primarily of performing mathematical techniques, such as explicitly applying an algorithm repeatedly. The third stage (Stage 2) is referred to as *creative (conceptual, constructive) activity*. This is the stage in which true mathematical creativity occurs and consists of non-algorithmic decision making.

Engineering & Technology in India www.engineeringandtechnologyinindia.com

ISSN 2472-8640 1:5 December 2016

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"The decisions that have to be taken may be of a widely divergent nature and always involve a choice" (p. 43). Although Ervynck (1991) tries to describe the process by which a mathematician arrives at the questions through his characterizations of Stage 0 and Stage 1, his description of mathematical creativity is very similar to those of Poincaré and Hadamard. In particular his use of the term "non-algorithmic decision making" is analogous to Poincaré's use of the "choice" metaphor. In looking for conspicuous patterns, mathematicians use such heuristics as (1) verifying consequences, (2) successively verifying several consequences, (3) verifying an improbable consequence, (4) inferring from analogy, and (5) deepening the analogy.

The Notion of Creativity in Mathematics

As stated earlier, research on creativity has been on the fringes of psychology and mathematics. It is only in the last twenty-five years that there has been a renewed interest in the phenomenon of creativity in mathematics. The Handbook of creativity (Sternberg, 2000), which contains a comprehensive review of all research then available in the field of creativity, suggests that most of the approaches used in mathematical creativity can be subsumed under five categories: mystical, pragmatic, psychodynamic, psychometric and social-personality.

Functions of Mathematical Creativity

Within every individual, mathematical creativity is a function of three components:

1. Expertise
2. Creative thinking skills
3. Motivation.

Expertise encompasses everything that a person knows and can do in the broad domain of his or her work- knowledge and technical ability. Creative thinking refers to how you approach problems and solutions - the capacity to put existing ideas together in new combinations. The skill itself depends quite a bit on personality as well as on how a person thinks and works. Expertise and creative thinking are the entrepreneur's raw materials or natural resources.

Engineering & Technology in India www.engineeringandtechnologyinindia.com

ISSN 2472-8640 1:5 December 2016

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Motivation is the drive and desire to do something, an inner passion and interest. When people are intrinsically motivated, they engage in their work for the challenge and enjoyment of it. The work itself is motivating. People will be most creative when they feel motivated primarily by the interest, satisfaction and the challenge of the work itself-“the labour of love”, love of the work-“the enjoyment of seeing and searching for an outstanding solution – a break through.

The entrepreneur is primarily concerned with developing new products, processes or markets, the ability to bring something new, product, processes or markets, the ability to bring something new into the market. The entrepreneur indulges in mathematical thinking more than any other person thinks and he is able to produce solutions that fly in the face of established knowledge. Entrepreneurs are inclined to be more adaptable and are prepared to consider a range of alternative approaches.

Creative outcomes seldom emerge in an instant: a recognized mathematical process is involved, even if it appears to be rather chaotic. It begins with recognition of a problem or anticipation of an opportunity, and then, through understanding the situation and reflecting on the issues, new linkages are contemplated and possible new combinations of components are aired: From this emerge visible solutions or possibilities that are subjected to valuation, which may be continuous with judgment being suspended while the search process is prolonged in pursuit of genuine newness.

Entrepreneurs take bold creative steps but situations encourage creativity. Mathematical Creativity is, however, enhanced when people have some freedom, but not too much; high internal commitment to the task; but not too high a commitment; high proportion of intense rewards, but some extrinsic rewards as well; some competition but not winner-take-all competition.

Innovation

Innovation is the process of bringing the best ideas into reality, which triggers a creative

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idea, which generates a series of innovative events. Innovation is the creation of new value. Innovation is the process that transforms new ideas into new value- turning an idea into value. You cannot innovate without creativity. Innovation is the process that combines ideas and knowledge into new value. Without innovation an enterprise and what it provides quickly become obsolete.

Innovation is the implementation of creative inspiration. The National Innovation Initiative (NII) defines innovation as “the inter-section of invention and insight, leading to the creative of social and economic value” Innovation is “value” – the creation of value adding value to customer’s satisfaction- “delighting the customers”. Innovation is the basis of all competition advantages, the means of anticipating and meeting customer’s needs and the method of utilization of technology.

Innovation requires a fresh way of looking at things, an understanding of people, and an entrepreneurial willingness to take risks and to work hard. An idea doesn’t become an innovation until it is widely adopted and incorporated into people’s daily lives. Most people resist change, so a key part of innovating is convincing other people that your idea is a good one – by enlisting their help, and, in doing so, by helping them see the usefulness of the idea.

Enterprises throughout the world are experiencing what can be legitimately described as a revolution: rising energy and material costs, fierce international competition, new technologies, increasing use of automation and computers. All these are major challenges, which demand a positive response from the entrepreneur and management if the enterprise is to survive and prosper.

Joseph Schumpeter (1934) believes that the concept of innovation, described as the use of an invention to create a new commercial product or service, is the key force in creating new demand and thus new wealth. Innovation creates new demand and entrepreneurs bring the innovations to the market. This destroys the existing markets and creates new ones, which will in

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turn be destroyed by even newer products or services. Schumpeter calls this process “creative destructions.”

The Entrepreneur and Entrepreneurship

What are entrepreneurs like? What distinguishes them from other business people? An entrepreneur is the man or woman who is able to actualize his/her innate potentials and develop a character that is not dependent but independent. He/she is that person who undertakes the voyage of creating value by pulling together a unique package of resources to exploit an opportunity. He or She has the capacity and capability to build something from practically nothing – initiating, daring, doing, achieving, and building an enterprise. They genuinely believe they have something new and special to offer, either a product or a service. To them, life will remain a fantasy unless their dreams are actualized.

Entrepreneurs have been described as people who have the ability to see and evaluate business opportunities, gather the necessary resources to take advantage of them and initiate appropriate action to ensure success. They are achievement- oriented, like to take responsibility for decisions and dislike repetitive and routine work. Entrepreneurs having mathematical creativity possess high levels of energy and great degrees of perseverance and inauguration, which combined with a willingness to take moderate, calculated risk, enable them to transform what began as a very simple ill- defined idea or hobby into something concrete.

Most importantly, entrepreneurs are the driving force of any nation; they are value-adders and represent the wealth of a nation and its potentials to generate employment. The entrepreneur may be a highly educated, trained, and skilled person or he/she may be an illiterate person possessing high business acumen, which others might be lacking. The mix of creativity and irrationality is what makes entrepreneurs tick and accounts for many of their positive contributions. Their visionary abilities and leadership qualities stand them out as human colossus.

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Entrepreneurship denotes the whole process whereby individuals become aware of the opportunities that exist to empower themselves, develop ideas, and take personal responsibility and initiative. In a broader sense, entrepreneurship helps young men and women develop new skills and experiences that can be applied to many other challenges in life. Entrepreneurship is therefore a key priority area with the potential to stimulate job and wealth creation in an innovative and independent way.

Entrepreneurship provides young people across the nation with valuable life skills and tools to empower them to build sustainable and prosperous futures for themselves and their communities. The concept of entrepreneurship has been associated with several activities concerned with the establishment and operations of business enterprises. Stevenson (1985) defines entrepreneurship as the process of creating value by putting together a unique package of resources to exploit an opportunity.

Entrepreneurship instills the enterprise culture into the individuals. Enterprise here is defined as resourcefulness, initiative, drive, imagination, enthusiasm, zest, dash, ambition, energy, vitality, boldness, daring, audacity, courage, get up, and go. Entrepreneurship, therefore, encompasses all the productive functions that are not rewarded immediately by regular wages, interest and rent and non-routine human labour. It is also not investing capital funds along. It is actually, the functions of seeking investment, production opportunity, organizing an enterprise to undertake new production process, raising capital, hiring labour, allocating resources, and creating new enterprises.

Challenge for Innovation

The place of innovation in commercial success is the development or adoption of new concepts or idea that leads to any form of increased organizational or social benefit. Innovation is vitally concerned with novel approaches, new ideas, and originality, and it the means by which ideas are exploited for competitive advantage.

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To succeed in business today demand constant innovation. Generating fresh solutions to problems and the ability to inherit new products or services for a changing market are part of the intellectual capital market that gives an enterprise its competitive edge. In a dynamic environment, success comes from looking for the next opportunity and having the ability to find hidden connections and insights into new products or services, desired by the customer.

While brain-power is the most valuable resource, great ideas are in short supply. Successful entrepreneurs place high premium on attracting and keeping talent because wealth flows directly from innovation. Creativity is the root of innovation. It is a process and a skill which can be developed and managed throughout the entire enterprise.

Creative ideas are not enough for your business to survive. You need a process organization and culture that will help you maximize your creative assets. This is innovation capability that helps you pull together the best thinking within your business, enabling you to connect the organization dots.

Shapiro argues that perpetual and pervasive innovation is the key to long –term sustainable success in the relentless competition for customers. To survive any competition, you must rapidly and repeatedly re-invent yourself. The road map to re-invention starts by applying the seven R's.

1. Rethink your underlying assumptions.
2. Reconfigure how you carry out work.
3. Resequence when work takes place
4. Relocate where work is done to cut down on handoffs and delays.
5. Reduce the frequency of carrying out specific activities.
6. Reassign who does the work by asking if anyone else could achieve the same result more effectively and efficiently.
7. Retool the technology that supports getting the work done. Could new software and automated equipment transform our ways of working?

Mathematical Creativity and Innovation in an Entrepreneurial Organization

Growth and development cannot be sustained without additional innovations (usually in the product or services or in its marketing) with additional innovations, firms become “glamorous” Introducing new products is usually seen as part of the process of innovation, which is itself seen as the engine driving continued growth and development.

The “winning performance” of the entrepreneur and the organization focuses on.

1. Competing on quality not prices
2. Domination of a market niche
3. Competing in an area of strength
4. Having tight financial and operating controls

To grow and prosper, most enterprises need to constantly improve their existing products and services through continuously innovating needed changes: and for survival of the enterprise, must also need to create new products and services to meet yet unfulfilled needs. Enterprises that rely exclusively on innovation will prosper until their products and services “ran out of gases and become obsolete and non-competitive. On the other hand, enterprise that are totally creative will have their new products and services ready to launch, but often too few current products sufficiently up-to-date and competitive to generate the cash needed to fund their creativity.

Changes are that the very successful leaders of the future will be more likely to make creativity and innovation a strategic priority in their organization. In today’s environment where competition requires business enterprises to be distinct and meet customer needs with better or never products and organization becomes in critical necessity.

Joseph Schumpeter views innovation as the source of success in the market economy, a view that is reinforced by today’s changing and competitive environment. The organization that is not creative and innovative cannot survive in the market place. Thus, entrepreneurs and enterprises are continuously creative and innovative to remain relevant to the customers, which is

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the purpose of every business.

Conclusion

Successful entrepreneurs require an edge derived from some combination of a mathematical based creative idea and a superior capacity for execution. The entrepreneur's mathematical creativity may involve an innovation product or a process that changes the existing order. Entrepreneur may have a unique insight about the course or consequence of an external change. Entrepreneurship is the vehicle that drives mathematical creativity and innovation.

No doubt, the current economic environment is a volatile and violent one. The new environment demands renewed dynamism of approach. Mathematical Creativity and innovation is the new name of the game. Only the discerning organizations can manage the changes inherent in the new environment. It is the duty of an entrepreneur to keep his/her organization lean, young, flexible, and eager for new things to continuously delight the customers, which is the purpose of every business.

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Engineering & Technology in India www.engineeringandtechnologyinindia.com

ISSN 2472-8640 1:5 December 2016

**Dr. C. Swarnalatha, Ph.D. (Ed.) Entrepreneurship and Management:
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