THE EFFECTIVENESS OF MTRIZP PROGRAM ON CRITICAL THINKING AND PROBLEM SOLVING SKILLS AMONG SAUDI ARABIA'S GIFTED AND TALENTED STUDENTS

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DEDICATION

I dedicate this humble work to the springs of loyalty, affection and virtue,my mother and my brothers,to my loyal companion ,my wife,who has alwaya been there for me, to my dear children.

Atallah Alatawi

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Although this thesis represents an achievement that bears my name, it would not have been possible without help of others who I would to thank. First, and for most, I thank Allah (SWT) for all his blessings and guidance.

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LIST OF ABBREVIATIONS AND ACRONYMS

CT	Critical Thinking
IQ	Intelligence Quotient
KSA	Kingdom of Saudi Arabia
MTRIZP	The Modified TRIZ theory-based Program
PS	Problem Solving
TRIZ	Theory of inventive problem solving. The acronym comes from the original Russian : Teoria Resheiqy Izibreatatelskikh Zadatch
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNICEF	United Nations Children Emergency Fund

KEBERKESANAN PROGRAM LATIHAN YANG TELAH DIUBAHSUAI BERDASARKAN MTRIZP BAGI MENINGKATKAN KEMAHIRAN PEMIKIRAN KRITIS DAN PENYELESAIAN MASALAH DALAM KALANGAN PELAJAR PINTAR CERDAS DAN BERBAKAT DI ARAB SAUDI

ABSTRAK

Tujuan kajian ini adalah untuk membina satu program latihan berdasarkan program TRIZ dan menilai keberkesanannya dalam meningkatkan pemikiran kritikal dan penyelesaian masalah dalam pelajar berbakat di Saudi Arabia. Pendekatan kuasi ekperimen pula digunakan bagi melihat keberkesanan Program TRIZ dalam meningkatkan kebolehan pemikiran kritikal dan penyelesaian masalah . Sampel kajian adalah terdiri daripada 80 orang pelajar yang telah disahkan sebagai pintar dan berbakat oleh Kementerian Pendidikan di Saudi Arabia . Sampel ini terdiri dari pelajar di tahap gred tujuh, lapan dan sembilan yang belajar di pusat Tabuk bagi berbakat di Tabuk. Sampel telah dibahagikan kepada dua kumpulan iaitu kumpulan ekperimen dan kumpulan kawalan. Kumpulan kawalan menerima program yang berterusan yang diamalkan oleh Kementerian Pendidikan Saudi Arabia sementara Kumpulan experiment pula menerima Program TRIZ. Ujian watson dan Ujian happner bagi tujuan ujian pengukuran kebolehan pemikiran kritikal dan Penyelesaian masalah dalam pelaksanaan ujian pra dan post bagi program pengayaan yang berterusan di bawah Program TRIZ. Data kajian di kutip menggunakan kaedah kualitatif (Protokol temu-bual bersama peserta dan guru) dan juga Kuantitatif (experimental). Hasil kajian menunjukkan program TRIZ mempunyai perbezaan yang signifikan dalam membangun kebolehan pemikiran kritikal dan Penyelesaian masalah para pelajar.

Perbezaan yang signifikan wujud dalam kalangan kumpulan experimen dan kumpulan kawalan (selepas intervensi). Kajian mendapati bahawa kebolehan pemikiran kritikal dan Penyelesaian masalah pelajar telah melonjak secara signifikan setelah diaplikasi Program TRIZ. Hasil kajian ini mendapati bahawa kelas juga mempunyai impak ke atas kebolehan pemikiran kritikal bagi kumpulan experimental dan kumpulan yang dikawal. Manakala tahap pendidikan ibu mempunyai impak ke pemikiran kritikal dan penyelesaian masalah. Didapati tiada korelasi yang signifikan antara pemikiran kritikal dan bapa pendidikan, umur and susunan kelahiran. didapati tiada korelasi yang signifikan antara penyelesaian masalah dan bapa pendidikan, umur, susunan kelahiran and kelas. Dan kajian ini turut mengesahkan bahawa kemampuan berfikiran kritikal dan penyelesaian masalah boleh ditingkatkan melalui program khusus yang mensasarkan kepada pembangunan kebolehan pemikiran kritikal dan penyelesaian masalah. Kejayaan program TRIZ dalam meningkatkan pemikiran kritikal dan penyelesaian masalah terletak pada reka bentuk program yang khusus.

THE EFFECTIVENESS OF MTRIZP PROGRAM ON CRITICAL THINKING AND PROBLEM SOLVING SKILLS AMONG SAUDI ARABIA'S GIFTED AND TALENTED STUDENTS

ABSTRACT

The purposes of this study were to construct a training program based on the TRIZ program and to measure its effects in enhancing critical thinking and problem solving of talented students. This study used a quasi-experimental method. A quasi experimental approaches were used in the effectiveness of the MTRIZ Program on critical thinking skills and problem solving skills. The study sample in this research consisted of talented seventh, eighth, and ninth graders who attend the Tabuk center in Saudi Arabia. The total sample number was eighty students, whom were divided equally into two groups, control and experimental. The control group received the regular enrichment program that is adopted by the Ministry of Education in Saudi Arabia, whereas the experimental group received the MTRIZ Program. Two instruments were used, watson test, which assessed the students level of critical thinking skills and happner test, which assessed the students level of problem solving skills. These instruments were used to assess the students' critical thinking skills and problem solving skills pre and post the application of the regular enrichment program or of MTRIZ Program. The data for this research were collected by using both qualitative (interview protocols with participating students) and quantitative (experimental) methodologies. The result of this study showed a significance difference in developing the critical thinking skills and problem solving skills of the talented students between the control and experimental groups (after intervention). The results also indicate that the talented critical thinking skills and problem solving skills

were significantly enhanced after the application of MTRIZ Program. Notably, class had an impact on the critical thinking; mother's education had an impact for the children whom mothers have postgraduate education on the critical thinking; mother's education had an impact for the children whom mothers have held university degree education on the problem solving. This study confirmed that critical thinking skills and problem solving skills can be enhanced through specialized programs, which target the development of critical thinking skills and problem solving skills.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Human resource is more meaningful than other resources if it is properly prepared and invested in the development, expansion, and diversification of production. The most significant proof of the importance of human resource is the development achieved in Japan and South Korea; these achievements include but are not limited to the fields of technology and science; these countries are not rich in natural resource, but they achieved progress because of proper utilization of human resource investment, especially for gifted and talented students who have the potential to innovate, invent, find solutions, and generate new ideas (Al-Tawwab, 1986). The future and progress of nations in terms of scientific and technological development largely depend on the interest and welfare of gifted and talented students and in providing a suitable climate to launch their creative potential (Mouawad, 1989).

Proper care should be provided to the gifted to enable them to develop and prepare their abilities and aptitudes and to ensure that they do not wither and are not extinguished. The gifted usually represent an important human resource that exceeds the value of any other national human wealth. The development and investment on human resource are essential to the individual and any society that seeks to advance and construct (Clerk, 1981).

MTRIZP was chosen as the basis for this study because that TRIZ theory features special characteristics, which include Engineering foundations that focus on the development of techniques of the systems, and Creative methods for solving

technical, administrative, and pedagogical problems in addition to the Ability to solve contradictions for technological and non-technological problems (Altshuller (2002).

The importance of MTRIZP for this study that MTRIZP was designed to bypass and/or overthrow psychological learning barriers. It is utilizes methodologies that are used to address advanced problems, which require resourceful, creative applications, and it is is efficient in analyzing expected outcomes and in selecting suitable means/processes to achieve desired outcomes. MTRIZP is effective in screening available resources and in choosing the appropriate resources and/or their adaptation to process requirements.

MTRIZP is important for gifted and talented student becouse MTRIZP consists of multiple methods for solving technical problems in such a way that the technical application is dependent on the cognitive framework, the principles of TRIZ can be taught to people to facilitate predictable inventions and to enhance creative thinking (TRIZ Journal, 2013). Altshuller et al, (2002). believed that invention is nothing more than the removal of technical contradiction with the assistance of a set of principles. He emphasized that one does not have to be born an inventor to be a good inventor (Lerner, 1991).

1.2 Background of the Study

The development of critical thinking is of particular interest to educators. Critical thinking includes five skills: (1) knowledge of assumptions, (2) reasoning, (3) discussion assessment, (4) inference, (5) and conclusion. Watson's critical thinking assessment is used as a metric for determining the level of critical thinking.

Education and psychology significantly contributed to our understanding of critical thinking processes and their elements. At present, education should be tailored according to the personal abilities of recipients. This approach matches education to thinking skills thereby facilitating its effectiveness.

Teaching approaches for gifted and talented students were given significant attention in the last few decades because the current curriculum does not provide them with elements that are appropriate to their development, cultivation of talents, and overall education. This scenario inspired many countries to include the category of gifted and talented students in the area of special education. This development was expanded to the establishment of specialized disciplines that focus on gifted and talented students in university systems. Thus, this group received improved cared because they were being trained by experts. Despite these advancements, education for gifted and talented students remains at its infancy. This field requires further studies to develop our understanding and ability to enrich the potential of this group.

Increasing interest in cultivating programs for talent and gifted students has been observed in the Arab world. Several areas of these programs are related to thinking processes that should be investigated to facilitate understanding of the methods that enrich the education of gifted and talented students. The present study aims to train gifted and talented students in Tabuk area. Training is centered on the development of critical thinking and problem solving skills.

According to a 1995 report of the Ministry of Education of the Kingdom of Saudi Arabia (KSA), educational policy in the KSA (1969: Article 57) includes general objectives to focus attention on the discovery and care of the gifted.

The policy confirms the importance of caring for outstanding individuals, identifying them, and constructing special programs to develop their talents. The policy also aims to create all means of scientific research that will help increase their abilities. Among the objectives related to the secondary stages are objectives that show the capabilities of students at this stage and direct them according to their potential (Al-Zahrani, 2001). Gifted and talented students are treasures of any society. They are the pioneers of thought, science, and art in all aspects of life of a state (Zehlouk, 2001).

Communities realized the importance of identifying individuals with high and distinguished potentials. They also realized the values of developing their capabilities and preparing leaders who are capable of raising their societies to prestigious cultural levels. The civilization attained by the Chinese Empire in 2200 BC in setting an accurate system for selecting gifted and talented students and providing them with appropriate programs are evidence of early efforts in this area (Abonyan and Al-Dhabyan, 1997).

Since the advent of Islam, Muslims nurture Muslim children with special capacities. According to Morsi (1992), Islam preceded modern practices in emphasizing the importance of genius, taking care of gifted and talented students, and highlighting their virtue in the social, economic, and cultural prosperity of their communities.

About 2%–5% of the population are considered outstanding, gifted, and talented. This percentage comprises scientists, thinkers, reformers , leaders, innovators, and inventors; since the ancient ages, humanity depended on these individuals for the progress of civilization because of their ideas of inventions, innovations, and reforms (Al-Qatiee et al., 2000).

1.2.1 General Information about KSA

The KSA is located in the Middle East in the Arabian Peninsula and has an area of about two million square meters with a population of about 29 million people. The main language of KSA is Arabic, and the major religion is Islam. The KSA is divided into 13 provinces. Tabuk occupies about 7% of the area of KSA and is located in the northwestern region of the country (Figure 2.1). Tabuk has a population of about 0.9 million people (Saudi Geological Survey, 2012). Tabuk City is the capital of Tabuk province.

The school education in KSA follows the traditional system, which is divided into elementary, middle, and secondary schools. The educational system involves gender-based segregation. The government announced that education is a top priority of the country. The government is eagerly involved in developing and adopting curricula and training teachers. In the past two years, the KSA adopted the curricula of McGraw-Hill for its science track. Thus far, the educational system employs rote learning (Aljughaiman & Grigorenko, 2013).

Aljughaiman, A. & Grigorenko E. (2013). Growing Up Under Pressure: The Cultural and Religious Context of the Saudi System of Gifted Education. Journal for the Education of the Gifted, 36: 307.

Figure 1.1. Geographic and provincial map of the KSA (Saudi Arabia, administrative divisions - ar - colored.png, 2015)

1.2.2 Gifted and Talented Students

Webster dictionary defines "gifted and talented student" as "whoever has the potential or the natural aptitude," whereas the term "gifted" also refers to "whoever has the potential (or ability) or the natural aptitude." This similarity refers to the use of two interchangeable terms used as synonyms (Merriam-Webster, 1979).

Arabic dictionaries show that the term "gifted and talented student" means "a characteristic that describes the individual that has an unusual high potential (or ability)." Until now, scholars did not specify the average IQ that describes this individual, but it is often set to 120 degrees or above. Mental level is usually related

to innovation or is used as a criterion in addition to some of the other characteristics of the individual (Al-Ashwal, 1987).

Arabic and English dictionaries agree that “talent” is the ability or the natural aptitude inherent in an individual. As far as educational and idiomatic aspects are concerned, identifying and defining the terms related to the concept of “talent” are difficult. These concepts are significantly detailed and unclear to use because of the multiple components of talent.

One of the most common definitions of “talent” is the provided by the Bureau of Education, which was adopted by the federal legislation of the gifted and talented student individuals in the United States in 1971. This adoption was known later as the definition of Maryland, which says that gifted or gifted and talented student children are those who are identified by the professionals and specialists. Such children have clear capabilities, and they have the ability for high achievement. They need special education programs and services more than those provided for normal students in normal programs in school to achieve their contributions to parents and the society at large. In addition to having high scores in their academic achievement, they stand out in one or more of the following capabilities; these capabilities include mental ability, specific academic readiness or aptitude, productive or creative thinking, ability of leadership, art or optical achievement, and mechanical ability (Al-Surour, 1998).

The fact that talent is a complex phenomenon and is not limited to the cognitive side must be considered. Talent is the power of memory and high achievement in the process of learning and thinking and similar processes. However, talent extends to the personality traits and emotional motivation. This broad direction

of the concept of “talent” can be observed in leading areas (leadership). Most of modern discussions focus on the need for gifted and talented student individuals that can exploit their talents and abilities in a distinct moral and desirable manner and not to exploit their talents. An example is to maximize their potential, gain personal wealth, and solve social problems such as poverty, environmental pollution, or unemployment (Al-Buhairi, 2002).

A gifted and talented student shows outstanding performance compared with those in his or her age group in one or more of the following dimensions: (a) high mental ability (IQ increases with one or two standard deviations), (b) high creative ability, (c) ability to achieve high academic level, (c) ability to do distinct skills (distinct talents, such as technical, mathematical, physical, or linguistic skills), (d) abilities of perseverance and commitment, high motivation, flexibility, and independence in thinking as the personal and mental attributes that distinguish the gifted and talented students from others (Al-Rousan, 1989).

1.2.2(a) Gifted and Talented Students In Saudi Arabia

In 1948, the KSA was the first country to establish a special section in training teachers of special education in several tracks, including academic achievement and innovation. Thus, Saudi Arabia can be considered as a nation that needs to ensure the establishment of an academic path at the undergraduate level to graduate special type of teachers to educate the gifted and gifted and talented students (Abdul–Jabbar, 2001).

The concern for the gifted and talented students basically started in the KSA in 1992 through the study of the draft program for the identification and care of the

gifted and talented students. This program was established in 1997 with the support and preparation of the King Abdul Aziz City for Science and Technology. The program was applied in the schools affiliated to the Ministry of Education. A public administration was also established in this regard to supervise the identification of the gifted and talented students in 2002. Among the most important objectives was to conduct the techniques and appropriate software to provide educational, psychological, and social care for the gifted and talented students (Al-Qatiee et al., 2000).

1.2.2(b) Centers of the Gifted and Talented Students in Saudi Arabia

The Center of the Gifted and Talented Students is an educational institution that operates in accordance with the prevailing social system in the KSA. This system works with a new thought and a new method. This system seeks to achieve the objectives of its education policy, particularly in the area of the gifted and talented students, through a range of programs and services geared to different age groups that wish to join the group. The center is run by a group of specialists and financed by private and public institutions. The center aims to discover and take care of the gifted and talented students in the various fields, age levels, and social groups. It also aims to satisfy their needs, provide necessary resources of care, and direct them toward the best investment. The talent center works to build a relationship between the gifted and talented students and different agencies and sectors with interest in this vein. Public management for taking care of the gifted and talented students in the Ministry of Education scientifically administers a number of talent centers across the KSA. These talent centers are connected to the departments of education in different regions and provinces. These centers opened in a number of cities including Riyadh,

Taif, Jeddah, Medina, Mecca, Dammam, Al-Ahsaa (Ministry of Education in the KSA, 2008).

These centers include activity groups with leaders, supervisors, mentors, and technicians of with greater experience and ability than those available in schools. Adequate budgets are allocated, and students are provided with additional time to perform activities through weekends, mid-year breaks, and summer vacations. The talent centers receive gifted and talented students nominated by schools, clubs and societies, and mosques. Tests are conducted to identify their talents in a scientific manner. Thereafter, the students are directed toward the appropriate educational activities, where they find care at a higher level than before (Al-Zahrani, 2000).

King Abdul Aziz City for Science and Technology is an institution created for science and technology. This institution solves the problems of society through scientific research based on objectivity and field experience concerning the importance of this issue. Two institutions are involved, namely, the Ministry of Education and the General Presidency for Girls' Education, and their responsibilities in this matter. A national project has been adopted for the development of education, including the program of identifying gifted and talented students and caring for them (Abu Nian, 1997).

The field of education in the KSA underwent significant development in the last 20 years. This development includes the spread, expansion, diversity, and upgrade of its programs, strengthening the potential of gifted and talented children, and providing care and attention to mentally retarded and handicapped children. Despite these developments, gifted and talented students do not receive adequate attention and care in terms of scientific efforts to identify them and provide them

with the educational programs appropriate for their care and learning. Given their talents and distinct abilities, this category should gain a significant degree of care and attention from the onset of childhood at home, at school, and the community because of the great payoff in the development and progress of society in return (Ministry of Education in the KSA, 2008).

Some signs of interest in this category started during the celebration in honor of academically talented students in the areas of education. They were given awards and material and moral support. Another sign is the establishment of awards of princes in some areas and the efforts of the General Presidency for Youth Care in encouraging talents in the arts and culture through clubs and art galleries. The International Award of King Faisal in the service of Islam and Islamic studies and Arabic literature, medicine, and science. This award emanated from King Faisal's Charity Foundation. Such an award represents an important symbol of the extent to which the leaders of this country estimate scientific excellence at the level of senior scientists and thinkers and their recognition of distinct individuals in the fields of religion, literature, science, and medicine at the global level.

Paying attention to the talents and excellence from childhood is important when talents and abilities are potentially viable to grow and aptitudes are in need of care and encouragement. These talents evidently exist, and they are possibly realized when the children grow up and become capable of expressing themselves and their abilities in the progress and development of society. Many centers and activities are found in some developed countries that reflect this concern. Among these centers are Future Scientists and the Young Mathematicians, the Olympics of the Mind contest, and the award of the President of the United States for scientific excellence. Talent

starts with the beginning of life as a potential that can expand with the growth and development of the individual in different stages of his or her life. Such a development can be ensured by a good environment that allow talent and potential to grow and flourish until it reaches the stage of achieving production and work. If it does not find adequate care and an appropriate environment, talent diminishes, disappears, and loses its usefulness for the individual and society. Talent and excellence from childhood can be nurtured when abilities are potentially viable to grow and aptitudes are in need of care and encouragement. These existing talents are possibly realized when children grow up and become capable of expressing themselves and their abilities in the progress and development of society (Alsharea, 2001).

1.2.2(c) Saudi Experience Concerning the Care of Gifted and Talented Students

The next subsections describe the many stages of development of care for gifted and talented students (Ministry of Education in the KSA, 2008).

First Stage

From 1990–1996, official efforts were provided by King Abdul Aziz City for Science and Technology, the Ministry of Education, and the General Presidency for Girls' Education. These reports facilitated the establishment of a research program that starts by identifying gifted and talented students and taking care of them in different educational levels. A national research project emerged, namely, "Identification and care program for the gifted and talented students." This project resulted in the preparation of standards in intelligence and creativity. This project included the preparation of two experimental programs in science and mathematics

as prototypes for gifted and talented student programs in the KSA.

Second Stage

The second stage involves the identification of gifted and talented students: This program was founded according to the minutes of the meeting headed by the Minister of Education, the Vice President of King Abdulaziz City for Science and Technology, and a research team (Alsharea, 2001).The project was adopted and applied in schools affiliated with the Ministry of Education by providing all potential human and technical resources needed for implementation. A working group was assigned, which was headed by Abdulnafee Al Sharee and the membership of the research team who implemented the program and provided detailed account of its establishment according to Ministerial Decree No. 877 dated 8/9/1996. Another program was inaugurated to address the needs of gifted and talented female students in the General Presidency for Girls' Education in 1997. Actual work started in the second semester of academic year 1998.

Third Stage

This stage involved the establishment of public administration for gifted and talented students. In the pursuit of the ministry to expand the programs of the gifted and talented students, a need emerged to create a public administration for gifted and talented students. This organization represented the educational system that would implement the policy of the KSA in taking care of gifted and talented students and achieving the objectives of the Ministry of Knowledge. A public administration was established to supervise the process of identifying gifted and talented students according to Ministerial Decree No. 58054 dated 6/6/2002.

Fourth Stage

This stage involved the establishment of a management system for gifted and talented female students. A department for gifted and talented female student care was established on 02/05/2001 as a result of the expansion of care programs for gifted and talented female students. On 25/5/2002, this management was linked to His Excellency the Deputy Minister of Education for Girls.

Fifth Stage

The fifth stage involved the unification of efforts in taking care of gifted and talented students: To unify the policies and business strategies in caring for gifted and talented students in the KSA, the decision of His Excellency, the Minister of Education, No. 373373 dated 24/6/2002 was issued. This decision assigned the responsibilities of the general management to take care of gifted and talented students regardless of gender.

1.2.3 Programs Offered by the Ministry of Education for Talented Students

First: acceleration of child transfer to upper levels

Second: administration of classes and private groups

Third: educational enrichment in regular classrooms

The Program for talented care in science and mathematics includes the following (Alsharea, 2001):

1 - Enrichment Program in Science

a) Specialized departments were established in the Ministry of Education and general directorates to work on the education of talented female students
b) Use of talented student-detection (identification) tools after circulation in the KSA
c) Study and discussion of the most appropriate methods for talented students in all disciplines
d) Development and monitoring of the implementation of programs in all disciplines for talented students in the KSA
e) Establishment of a highly specialized center for talented students in science and mathematics supervised by the Department of Awareness at King Abdul Aziz City of Science and Technology to provide summer programs for talented students in science and mathematics at the secondary level
f) Incorporation of educational enrichment activities to the science curriculum at all educational levels for boys and girls to be performed only by talented students already identified by detection tests applied in the Saudi environment
g) Establishment of a specialized center for talented students in science for boys in each educational department. This center provides programs in the evening or during weekends or summer vacations or a combination of them. In large cities such as Riyadh, more than one center are established to facilitate transportation and the geographical distribution of students.
h) Development of research skills among science teachers through training courses
i) The need for one or more subjects in the curriculum of educational training in the colleges of education and teachers' colleges in the KSA. These curricula

focus on introducing talented students to future teachers in terms of their characteristics to detect these subjects and how to take care of them.

2- Enrichment Program in Mathematics

a) Teaching advanced topics in mathematics that focus on solving usual and unusual issues
b) Using computers in teaching talented students by teaching programming and taking advantage of the mathematical programs in addition to providing an opportunity for students to access information databases and link all data to the information taught in the classroom
c) Providing a learning environment that contains necessary educational tools to link the abstract material to the scientific aspect
d) Choosing an appropriate time for students to enroll in such programs when they are exhausted after attending their usual school courses in the morning
e) Taking advantage of existing programs in some of the developed countries in this area but considering the suitability of the educational environment in the KSA

1.3 Problem Statement

The increasing worldwide diversity calls for creative and complex thinkers. Given the current speed of information discovery, the quantity of available information is estimated to double every 10–18 months (Murgatroyd, 2010); this rapid growth of information requires emerging adults to recall information from their academic experiences and continually incorporate new ideas into knowledge they already know. As the complexity of society increases, the types of problems that students

will face after schooling will become increasingly complex, which will result in increased demand for proficient (Noykes, Schunn, & Chi, 2010) and creative thinkers (Sternberg & Lubart, 1996). A number of theorists (Romer, 1994) also believe that economy will be driven by creative and innovative products and solutions that respond to critical societal needs.

Schools are at the heart of educational systems. However, most students obviously lack important thinking skills. Clement (1979) highlighted the educational challenges encountered by schools: "We should be teaching students how to think. Instead, we are teaching them what to think." Norman (1981) also expressed his dissatisfaction with the educational system: "It is strange that we expect students to learn, yet seldom teach them anything about learning." Given the differences in abilities and potentials of students, an ideal school system should undertake learning that matches the abilities of students (Knight & Becker, 2000). Unfortunately, most schools still lack appropriate procedures for identifying talented students (Malik & Balda, 2006; Winebrenner, 2000).

Substantial research has been conducted to identify the characteristics of gifted students, whereas other research focused on pedagogical practices in the education of gifted children (Garni, & Abdullah, 2012; Abunayyan, 1994; Reis & Renzulli, 2009; Renzulli, Smith, & Reis, 1982; Silverman & Baska, 1993; VanTassel-Baska et al., 2009). Despite the availability of these studies, the majority of gifted students throughout the world spend most of their time in regular classrooms (Hyatt, 2000; Maajeeny 1990). The National Association for Gifted Children in the US (2011) published its 2010–2011 annual report entitled "State of the Nation in Gifted Education." The report showed that gifted students spend the majority of their time in regular classrooms and they receive instruction from

teachers who are not trained to meet their needs. The majority, if not all, of gifted students in Saudi Arabia spend most of their time in mainstream classrooms (Al Qarni, 2010; Maajeeny, 1990). The downside of this situation is the tendency of gifted students to easily and quickly complete mainstream tasks and problems (Winebrenner, 2009); they also frequently become bored (Cohn, 2003) and frustrated (Delisle & Galbraith, 2002). Subsequently, they may lose interest and ultimately underachieve. In addition to the adverse effect on the academic process, the lack of special attention for unidentified talented students may leave negative implications on the self-esteem and motivation of talented students (Knight & Becker, 2000). Gardner (2004) suggested that gifted students must be provided with different instructions that can match their unique abilities to enable them to overcome the risk factors of academic achievement and motivation.

Given the explosion of information technology and the shift from an industrial society to a knowledge society, the attitude or disposition to think critically has become as important as other skills (Halpern, 2003; Pascarella & Terenzini, 1991), such as professional acquisition of knowledge and lifelong learning (Tiwari, Lai, So & Yuen, 2006). Understanding the nature of critical thinking and how it can be acquired could help educational institutions instill such skills in their educational strategies and hence become effective and efficient. Critical thinking is an important skill in the category of talented students because it is through the development of critical thinking skills that talented students are driven for academic and social success.

Critical thinking is a high-order type of thinking. Critical thinking is a non-algorithmic, complex mode of thinking that often generates multiple solutions. Low-level taxonomy under Bloom's classification, such as knowledge, can be considered

low-order thinking skills, whereas high-level taxonomy, such as analysis, synthesis, and evaluation, can be considered high-order thinking skills. The combination of multiple elements of critical thinking forms other skills including, but not limited to, problem solving, inferring, estimating, predicting, generalizing, and creative thinking. This finding suggests that problem solving is preceded by critical thinking.

Critical thinking also affects the acquisition and retrieval of knowledge because concepts are acquired through abstractions. Moreover, principles connect these concepts, which result in the establishment of a network of knowledge. New concepts must fit into the existing cognitive structure. Such an accommodation will not be possible without critical thinking. When a problem occurs, it must be analyzed critically before it can be solved by asking the following questions: What is the problem?, What is the given information? Critical thinking is continually involved in problem solving.

Problem solving involves a skill required in all aspects of daily life. Most people make daily plans, make business decisions, and manage their budgets. These activities require logical thinking and problem solving skills (Wedemann, 1995). Problem solving is an important life skill that involves a range of processes including analyzing, interpreting, reasoning, predicting, evaluating, and reflecting (Anderson, 2009).

Problem solving has many definitions. The following definitions encompass most of these definitions. For Polya (1973), a pioneer in problem solving, “solving a problem means of finding a way out of a difficulty, a way around an obstacle, attaining an aim that was not immediately understandable.” According to Green and Gilhooly (2005), “problem solving in all its manifestations is an activity that

structures everyday life in a meaningful way and that problem solving draws together different components of cognition." Annable (2006) stressed the importance of problem solving and pointed out that problem solving skills are potentially manifested in developing students' responsibility and increasing their motivation for learning and its retention. In addition, problem solving strategies are effective in collaborative learning settings (Annable, 2006).

Educational systems at present continually struggle to engage students in critical thinking and problem solving activities (Tempelaar, 2006), but students seldom use critical thinking skills to solve complex, real-world problems (Bartlett, 2002; Rippen, Booth, Bowie, & Jordan, 2002). Existing studies show gifted students cannot develop their potential on their own (Fiedler, Lange, & Winebrenner, 2002; Winebrenner, 2000, 2009). To unleash their potential, they must receive adequate training from qualified teachers. Çetinkaya (2014) confirmed such connection by using a problem solving program administered to talented students. Cetinkaya's research indicated that problem solving is directly linked to creative thinking skills. Therefore, institutional programs should be developed that target the development of critical thinking and problem solving. These programs can bridge the gap in the education of talented students and in providing them with means to excel.

Talented students should be taught how to think critically to foster their development. Critical thinking training should be included in programs that target talented students; this can only happen, however, if professional programs in these disciplines evolve accordingly by not only teaching content but also teaching processes of how to think (Ahuna et al, 2014; Cabrera & Colosi, 2009).Critical thinking training can help talented students practice rigorous thinking, evaluate ideas

and concepts, and understand the underlying nature of things. Training in critical thinking can sculpt the personalities of talented students and empower them to face difficult, real-life problems. Critical thinking training for talented students can also boost their self-confidence and self-dependency. Such a training can also enrich the cultural and ideological rationale of students. Critical thinking training can lead students to apply methodologies in evaluating and comparing ideas and concepts before accepting them. Thus, it can reduce the likelihood that students will accept false logic or an unsupported idea or concept. Another benefit of critical thinking training is reduced arrogance and tendency to underestimate others or to undermine new ideas and concepts. Critical thinking can strengthen the abilities of talented students to identify contradictions and logical fallacies (Al-Sukary, 2010).

Educational systems in many countries are continuously realizing the importance of fostering high-level thinking skills, which are directly linked to high abilities in reasoning, evaluation, analysis, and conclusion (Al-Sharafi,2005). These abilities are also necessary in enhancing the specific talent of each student (Astleitner, 2002). The inclusion of critical thinking training can stimulate and advance the mental abilities and skills of these students (Al – Rafei, 2012). However, this success is contingent on educational support and on the specific environment that can affect the customization of critical thinking exercises and activities. Moreover, the inclusion of critical thinking training into these programs should emphasize the excitement and dynamicity of critical thinking (Halpern, 1998).

According to Harnadek, Anita (1976), every student can exercise critical thinking if he or she receives appropriate and adequate training (Jarwan, 2002; Bahjat, 2005; Abrami,, 2008). The author arrived at this conclusion because the application of critical thinking can lead to strong and deep cognitive content and

facilitate the ability to dynamically utilize such a skill (Al-Hamory & Al-Wahr, 1998).

The emphasis on the importance of fostering talented students was also evident in conferences held in many countries. In 2000, Connecticut University held "Teaching and Learning Enrichment for Fostering Talented Students." In 2005, the conference on "Fostering Talented Students is an Arabic Priority in the Globalizing Era" was held in Amman, Jordan. The Jeddah/Saudi Arabia Fourth Annual Reginal Scientific Conference entitled "Fostering Talented Students-Pedagogy for the Future," which was held in 2005, was focused on fostering talented students. The conference addressed the importance of teaching and enhancing the different types of thinking including critical thinking. Based on the consensus on the importance of advancing thinking skills, the conferences recommended the vital importance of research in understanding and developing programs that address teaching and learning of thinking, particularly critical thinking (Al – Rafei, 2012).

Existing research data and the recommendations of conferences on advancing the teaching and learning of talented students suggest the importance of critical thinking skills of talented students. The value of critical thinking is attributed to personal and societal benefits. The present study was conducted to address the scarcity of research to advance the critical thinking abilities of talented students in Arab countries in general and in Saudi Arabia in particular. In this study, we attempt to shed light on advancing research on critical thinking. The present study followed the developments achieved in developed countries that have placed the advancement of thinking skills at the top of their agenda and social priorities. Despite the consensus on the importance of teaching critical thinking skills, this subject is still taught within the context of other disciplines. Thus, the present study focuses on

teaching critical thinking skills in an interdisciplinary approach. This study aims to teach critical thinking skills in a broad context to help talented students apply their acquired knowledge and skills in real-life situations. This study is of crucial importance to the Saudi Arabian society because it focuses on the interdisciplinary approach of teaching critical thinking to talented students.

One of the most recognized theories in the world is TRIZ. TRIZ has been constantly evolving since its inception; a yearly conference addresses the continuous development of TRIZ theory (www.aiTRIZ.org). Altshuller (1984) conceptualized this theory by identifying and codifying principles that enabled people to invent; these principles are the basic, universal drives for creative thinking. According to Altshuller (1999), these principles can be taught to people to facilitate predictable inventions and to enhance creative thinking (TRIZ Journal, 2013). Altshuller et al, (2002). believed that invention is nothing more than the removal of technical contradiction with the assistance of a set of principles. He emphasized that one does not have to be born an inventor to be a good inventor (Lerner, 1991).

When used in isolation, TRIZ principles can be used as part of brainstorming to create ideas and solutions. However, the philosophy of TRIZ is focused on problem solving effort in areas that are likely to be successful instead of generating large quantities of ideas (TRIZ Journal, 2013). The proponent criticized the trial-and-error method, which is normally used to make discoveries. The definite roadmap and concise target of TRIZ principles makes this theory an attractive model for implementing the development of thinking processes, particularly in the area of critical thinking and problem solving. TRIZ theory was originally modeled for technical problems, but it can serve as the foundation for non-technical and educational purposes given its flexibility and universality.

Bowyer (2008) confirmed the effectiveness of TRIZ principles in solving non-technical problems by non-specialized individuals. Bowyer's research supported the argument that TRIZ principles can improve certain aspects of critical thinking abilities of an individual. Therefore, TRIZ principles can improve the problem solving ability of participants because critical thinking processes precede problem solving. In addition, the dynamicity of TRIZ principles allows them to be an effective and efficient tool for training and in conducting group problem-solving exercises.

A growing interest in talented students has been observed in Arab societies, and serious steps have been taken to identify talented students in an attempt to provide them with necessary care (Aljughaiman & Grigorenko, 2013). However, educational policy toward gifted students, which was initiated in 1969 (Ministers No. 779 dated 26/11/1969), directed the educational system to identify and care for talented students within the framework of public programs (Public Management, 2001).

The education of gifted students has emerged as a strong and noticeable subject in many countries including the KSA. The policy of education in the KSA recognized the special needs of the gifted group and the necessity for developing them. To provide gifted students with the streams of culture and the appropriate expertise, KSA decided to construct special programs and curricula. The policy also concentrated on providing the gifted with tools for scientific research to invest in their talents and abilities. KSA's efforts in identifying and caring for gifted students are substantial, important steps in driving the prosperity of the country. The main objectives of the educational policy in KSA are to identify gifted students and to provide them with opportunity and different potentials. Through this policy, the

country hopes that the talents of students are well cared for within the framework of public programs (Al-Mousa, 1999). The ability to think is a distinct feature of human beings. The quality of our thinking distinguishes us from other members of our own species. Critical thinking facilitates our improvement and progress. Not all natural thinking process leads to excellence. Scriven, M. and Paul, R. (2003) suggest the cultivation of critical thinking to prevent bias, distortion, partiality, uninformation, and prejudice. This study examined enthusiasm on the development of critical thinking in education. Teaching critical thinking skills have gained considerable attention in educational research. Glaser's (1941) seminal work reported that training programs have beneficial effects on different aspects of critical thinking elements. MacBride and Bonnette (1995) also reported that training and education can foster critical thinking in at-risk groups. In his comment on Atkinson's (1997) article, Davidson (1998) maintained that critical thinking should be introduced even if it is considered a culture-specific trait.

These discussions display the importance of the integration of critical thinking and problem solving into the educational system in general and in the enrichment programs for talented students in particular. The present study aims to use the principles of MTRIZP to develop the critical thinking and problem solving skills of talented students in Saudi Arabia. MTRIZP is flexible, dynamic, systematic, and versatile. Most importantly, it targets critical thinking and problem solving. The researcher selected 10 principles of the TRIZ program. The selection of these principles were based on their ease of adaption and suitability to create a training program, namely, MTRIZP. This program aims to develop the creative thinking and problem solving skills of talented students in Tabuk, KSA. The following TRIZ principles were selected: (1) segmentation, (2) extraction, (3) merging, (4) inversion,