Iranian Journal of Comparative Education, 2022, 5(2), 1871-1897

Research Article DOI: 10.22034/IJCE.2022.273973.1288 http://journal.cesir.ir

A Comparative Study of Mathematics Curriculum in Primary Schools of Iran and Singapore

Nahid Mehrjoo[1]
Mohammad Nourian[2] (Corresponding author)
Dariush Norouzi[3]
Mahmoud Abai Kopai[4]

ARTICLE INFO

Received: 02 February 2021
Revised: 11 April 2021
Accepted: 27 July 2021
Online: 11 March 2022

KEYWORDS

Content
Curriculum
Goal
Mathematics
Primary Education

ABSTRACT

Learning mathematics creates opportunities for pupils to develop key 21st century competencies. In support of this important curriculum, more serious efforts are needed to update the content and technique of mathematics education. The aim of research was a comparative study of primary school mathematics curriculum in Iran and Singapore in four components of objectives, content, teaching and assessment methods. A comparatively qualitative research method has been done using Bereday's four-step approach. The sample selection strategy was "Different social systems, different educational outcomes". The data were collected using documents and information available in formal government databases, books and publications related to the research topic in the period 2021-2000, and were analyzed according to the John Stuart Mill agreement / disagreement method. The findings showed that selected countries emphasize the development of thinking skills and creative activities in mathematics education's goals. In terms of goals, most important difference between the two countries is that Singaporean education system supporting the "problem solving" method and creating coherence between the content and skills taught to the learners. Also in contrast to Iran, in Singaporean schools, students' individual differences in content and metacognition development in learning strategies have been addressed. In order to improve the educational quality of Iran, curriculum planners are advised to consider new methods of content preparation and mathematics education.

[1] Ph.D. Student, Department of Educational Sciences, South Tehran Branch, Islamic Azad University, Tehran , Iran, Email: nahidmehrjoo@yahoo.com
[2] Associate Professor, Department of Educational Sciences, South Tehran Branch, Islamic Azad University, Tehran, Iran, Email: mnourian2001@yahoo.com
[3]. Associate Professor, Department of Educational Sciences, Allameh Tabataba'i University, Tehran, Iran, Email: drdnoroozi@gmail.com
[4] Assistant Professor, Department of Educational Sciences, South Tehran Branch, Islamic Azad University, Tehran , Iran, Email: m_abaee44@yahoo.com

1. Introduction

Primary education, as one of the most important educational level, requires innovative support in the curriculum to create rich and enjoyable learning conditions. In this stage, in addition to the formation of personality and all-round inclusive development, most basic skills and attitudes of pupils are also formed (Caldwell, 2019). That is why modern societies are constantly striving to adapt educational systems to global conditions so that learners - as 21st century citizens - with flexible thought have demonstrated all their ability to understand and apply concepts and gain practical and cognitive experiences (Abramovich et al., 2019; Brezovnik, 2015). In the meantime, teaching mathematics - as an activity that involves the participation of thought processes in problem solving - can create a variety of learning opportunities; encourage children to discover, recognize and structure their knowledge; and while gaining skills appropriate to the needs of the present time helped them to better understand their abilities (Battelle for Kids.org, 2014); Ministry of Education Singapore, 2021). In fact, mathematics is a universal language, and its role and place - as a subject and a natural flow in human thought - is formed from the child's first experiences of playing with simple patterns and can gradually take the form of creative "activity." In addition to stimulating the mind and making knowledge attractive, it is also effective in strengthening the power of foresight and problem solving (Derosa, 2017; Gholam-Azad & Gooya, 2016). In other words, "Mathematics as an art and a system of ideas" (Borel, 2017: 28), can both strengthen the power of reasoning and establish an intellectual order in students, and in all aspects of education and life (Coffland & Xie, 2015). In fact, the purpose of mathematics education is not only to maintain and learn basic skills, but also to identify the causes of misunderstandings in teaching, to provide learning opportunities for understanding and applying skills that require in-depth insight and more rational and creative (Ministry of Education Singapore, 2021). Although standards of curriculum emphasize the importance of conceptual understanding of mathematical problems (Schoenfeld, 2007; Wynn & Harris, 2012), but At the same time, researchers' findings reveal that curriculum planners, teachers, and parents face many challenges in teaching children math (Wiggins & McTighe, 2005; Coffland & Xie, 2015; Willoughby, 2010). One of these problems is the lack of connection between the content of the math lesson and pupils' real life (Coffland & Xie, 2015: 311). Research shows that daily life is full

of problems that require use of mathematical reasoning, and therefore school curriculum should provide the ability to apply mathematics to prepare students for real-life situations (Stacey, 2005; Pea & Martin, 2010; Esmonde et al. 2013; Liao, 2016). Another challenge is the lack of connection between mathematical concepts in different educational stage (DeRosa, 2017).

A coherent curriculum should be interconnected through different educational backgrounds so that students gain a deeper understanding of the concepts (CCSS, 2014). The third challenge is lack of integrating mathematics curricula with other subjects (Coffland & Xie, 2015; Brezovnik, 2015). Yekman (2012) claims that when knowledge is transferred from one discipline to another, we gain greater depth of knowledge that can be used in the real world. Therefore, less attention to these challenges can gradually have a negative effect on development of metacognition and thinking skills in learners (Bakhshalizadeh & Broojerdian, 2017). The results of international tests also indicate an unfavorable trend in mathematics education in many countries, including Iran (Mullis et al., 2019; Minaei et al., 2013). Shirazi et al. (2016) showed that part of students' poor performance in "Trends in International Mathematics and Science Study" (TIMSS) tests is due to educational approaches and methods that play a key role in meaningful understanding and generalization of students' learning. In this regard, Rafiepour & Goya (2012) and Kasiani & Zarei (2012) have stated that Iranian students perform poorly in international exams due to their lack of skills in comprehension, analysis and inference of mathematical problems. Yazdani & Hassani (2011) also confirms the fact that in Iran, different areas of educational goals in primary school curricula are not balanced and less attention has been paid to attitudinal objectives. In other goals, the attainment of the minimum qualifications has been satisfied. This discrepancy also exists between the content of math textbooks and learning objectives with the reality of educational environments - such as teachers' expertise and beliefs, students' needs, and teaching time (Azizi Mahmoudabad & Nili, 2019; Dehghani & Safdari, 2014).

In this regard, Singapore has been able to deepen knowledge and understanding of its students by demonstrating thinking skills and strengthening a positive attitude towards mathematics. The education system of this country has been able to take mathematics learning to the next level while earning top rankings in international examinations like

TIMSS & "Programme for International Student Assessment" (PISA) (Ministry of Education Singapore, 2021; Lee, 2019; Wong et al, 2019). This fact reveals the need for a comparative study of the Iran mathematical education system and its comparison with the performance of developed countries, such as Singapore. This study helps curriculum planners to draw a comprehensive map of the desired situation in the objectives and pillars of the mathematics curriculum. Therefore, it is necessary to review previous research systematically, and to extract, analyze and evaluate existing lessons in order to provide an optimal method for mathematics education in Iran. The main purpose of study was to find out what are the main similarities and differences between primary school mathematics curriculum of Iran and Singapore. To answer this question and its dimensions, the sub-questions of the research were organized as follows:

- What are the similarities and differences between goals of the primary school mathematics curriculum in Iran and Singapore?
- What are the similarities and differences between contents of the primary school mathematics curriculum in Iran and Singapore?
- What are the similarities and differences between teaching methods of the primary school mathematics curriculum in Iran and Singapore?
- What are the similarities and differences between assessment methods of the primary school mathematics curriculum in Iran and Singapore?

2. Research Method

The purpose of study was to compare the mathematics curriculum in primary school in Iran and Singapore. For this purpose, the present study is a comparatively qualitative research using method of George, F. Bereday (1969), in four stages of description, interpretation, juxtaposition and comparison. The research sample was selected based on the strategy of "different social systems, different educational outcomes". Data were collected using documentary methods from databases of governmental institutions and organizations, books and publications. In Iran, information bases such as "National Curriculum of the Islamic Republic of Iran" (2013), the "Document of Fundamental Transformation of Iran's Education" (Supreme Council of Cultural Revolution, 2011), Mathematics Teachers Handbook, the "Organization for Educational Research and Planning" and in Singapore, the resources available in the information bases of Singapore

Primary Mathematics (2021), and the "National Council of Teachers of Mathematics" (NCTM) were used. The internal and external validity of the documents were examined. To determine internal validity, the accuracy of documents and for external validity, the importance degree of documents was evaluated. Data were analyzed using the John Stuart Mill agreement / disagreement method (Finn, 2010).

3. Findings

This section contains information on the four steps of description, interpretation, juxtaposition, and comparison. In the first step, the current state of the primary education system in Iran and Singapore is briefly explained. Then, at two stages of interpretation and juxtaposition, the elements of mathematics curriculum – i.e. goals, content, teaching methods and evaluation methods – in both countries are examined. Finally, in the comparison phase, the results of the similarities and differences between the two countries in terms of mathematical curriculum elements are presented.

A) Description

At this stage, information about characteristics of the selected educational systems is provided.

1. Iran

In Iran primary education, the process of planning, compiling, printing and supervising school textbooks is carried out directly under the Ministry of Education, and all schools are required to implement it. Decisions on the adoption of rules and regulations are also in the hands of the Supreme Council of Cultural Revolution and Higher Council of Education (Askari, Elahimanesh & Parizad, 2019). In the National Curriculum Document of the Islamic Republic of Iran (2013), the student is defined as a divine trust that has the ability to flourish and materialize. The teacher is also a role model who, by recognizing and creating educational opportunities, provides chances to increase learners' motivation for intellectual, faith, scientific, practical, and moral development (Supreme Council of Education, 2013). According to upstream documents, the mission of primary education is to nurture the talents of learners by creating appropriate opportunities for teaching /

learning. In addition, the importance of learning values and cultural heritage and a common language for the development of national identity is emphasized (Salsabili, 2017). Pupils are expected to achieve a level of basic competencies during their school years (Supreme Council of Education, 2013). In Iran, the age of entering primary school is six years old and the length of this period is 6 years. Primary education is divided into two separate three-year stages: First stage (first, second, third grade) and second stage (including fourth, fifth, sixth grade). Common subjects in all grades are reading and writing, math, science, art, and the Quran. In the third grade, the subject of social education, and in the sixth grade, the subjects of work and technology and thinking & research are added. Out of a total of 24 educational hours per week, in the first and second grades, 5 hours and in the other grades 4 hours is dedicated to mathematics (Askari et al, 2019).

2. Singapore

In this country, the Ministry of Education has a very active role in the management of schools and curriculum (Elmore, 2004). Mathematics courses are prepared and designed by the Ministry of Education in collaboration with the “University of Cambridge Local Examinations Syndicate” and notified to schools. Also, this course is reviewed periodically every six years to ensure that it is appropriate to prepare students to meet global challenges and align with national goals. In the event of a need for change, often the core of the curriculum remains constant in the reform process (Kaur, 2013). In this country, education is a continuous movement towards learning, participation and innovation (Askari et al, 2019). This dynamism in the education system has improved curricula across schools (Wong et al, 2016). Establish a perfect relationship with other countries and while investing in research centers, Singapore spread ideas such as “creative thinking” and "less teaching, more learning" at the school level (Wong et al, 2019).

Primary education programs in this country are based on modern learning and assessment standards (Al-Jaafari, 2017). Other characteristics of Singapore's primary education system include teaching the characteristics of multinational and multicultural societies, as well as adhering to a bilingual policy in the country. The goal of learning a mother tongue - such as Chinese, Malaysian or Tamil - is to return to identity, and values (Caldwell, 2019). One of the most important educational goals of this country is to help

discover the talents of children and to pay attention to individual differences in the ability and speed of learning. In the changing global context, this country has considered the goals and visions of its education system in accordance with the needs of the twenty-first century (Wong et al., 2019) and based on the vision of " Thinking Schools, Learning Nation " (Caldwell, 2019). The purpose of this educational system is to raise children whose learning never stops (Deng, Gopinathan & Lee, 2013). This approach, based on professional advancement and personal enrichment, determines continuous progress in this country (Hallinger 2005; Leithwood et al, 2004). In Singapore, the age of entering primary school is six years and its length is also six years, with pupils taking four years as an introductory stage and a two-year course with the aim of choosing a major. At the end of the sixth year, pupils have to participate at the “Primary School Leaving Examination” (PSLE) (UNESCO-IBE, 2007). Although mathematics is a compulsory subject in this country, its breadth and depth depend on the learners' abilities. Math classes are 4 hours per week in the first and second grades and 5 hours per week in other grades of primary schools of Singapore. In Singapore, all subjects - except mother tongue - are taught and evaluated in English so that students have sufficient proficiency in it - which is the language of business, science and technology (Ministry of Education Singapore, 2019).The development of information and communication technology is one of the pillars of Singapore, so that in the 1990s the term " Intelligent Island " was used to refer to this country, because the country was able to quickly adapt to the world of the Internet (Shekarbaghani, 2012: 57)

B) Interpretation and Juxtaposition

1-Goals

Iran:

In the curriculum of the Islamic Republic of Iran, mathematics is defined as the science of patterns and communication, a way of thought, a regular art with internal consistency, and an accurate tool for defining terms and symbols. The purpose of mathematics education is to train people who can reason logically, have the power to decompose and abstract, to construct a comprehensive theory of external phenomena, and to be able to apply mathematics to solve daily life problems (Supreme Council of

Education, 2013). In Iran, there is a formal mathematics curriculum that outlines the content objectives, concepts, and skills that need to be learned (Reyhani, 2016). In addition, the main purpose of teaching mathematics is to develop acquired thoughts and thinking skills in learners, so that they can communicate creatively and find appropriate solutions to problems by strengthening their predictive power (Alamian, 2012; Gooya, 2010). The National Curriculum of the Islamic Republic of Iran (2012) emphasizes that mathematical concepts should be taught in the context of concepts related to other scientific fields. However, how the mathematics curriculum relates horizontally to other subjects is not specified and is taught independently (Higher Council of Education, 2012).

Singapore

In this country, in addition to the framework set by the Ministry of Education, schools can continuously refine, review and change the objectives of mathematics education by determining the appropriate perspective with the context and location of each school (Fullan, 2006: 157). Therefore, the mathematics curriculum in the primary school of this country does not consider any formal education. The main focus of the objectives in this curriculum is to develop vital mathematical processes so that with the growth of 21st century competencies and the development of great ideas in mathematics, it can create a deep knowledge and understanding of mathematics in students (Ministry of Education Singapore, 2021). Although the primary goal of mathematics education in Singapore is problem solving, learning concepts and learning thinking and problem-solving skills and strengthening, a positive attitude toward mathematics have also been important (Ministry of Education Singapore, 2021; Kaur, 2013). Levels of goals in this subject are based on the principle of "Mathematics for all, advanced mathematics for some" (Ministry of Education Singapore, 2013). This spiral approach allows higher concepts and skills to be built on a more basic basis and learned over a period of time. These goals, which are developed with a strong foundation in mathematics to strengthen three broad levels of mathematics education, are categorized as follows:

A- Basic goals (strong foundation):

- Application of concepts and mathematical skills for daily use and continuous learning,

- Development of thinking, reasoning, communication, application and metacognition skills through problem solving approach,
- Strengthen confidence and interest in mathematics.

B- Secondary goals (strengthening abilities)

Level 1- The purpose of teaching mathematics is to enable all students to

- Acquiring mathematical concepts and skills for continuous learning and supporting learning of other subjects,
- Development of thinking, reasoning, communication, application and metacognition skills through a mathematical approach to problem solving,
- Connection between mathematics and other subjects through application of mathematics; and
- Strengthen confidence and foster interest in mathematics.

Level 2 - Supplementary Mathematics helps talented and interested students to:

- Acquiring mathematical concepts and skills for further study and helping to learn other subjects;
- Development of problem solving skills, thinking, reasoning and metacognition skills through a mathematical approach;
- The connection between ideas within and between mathematics and other sciences through the application of mathematics;
- Understand the abstract nature and power of mathematics.

Level 3- Math curriculum provides opportunity for students interested in vocational education:

- Acquisition of mathematical concepts and skills for real life;
- Supporting learning of other courses and preparation for vocational training;
- Strengthen self-confidence and understand the value of making informed decisions in real life using mathematics (Ministry of Education Singapore, 2013).

2- Content

Iran

In this country, most educational activities take place within the framework of the school textbook, so the content of textbook has a special role and position in the learning process. According to the recommendation of the National Curriculum Document, the content of mathematics is divided into two general parts: Mathematical concepts and processes (Higher Council of Education, 2012) (Table 1).

Table 1
Content Framework in Iran Primary Mathematics Curriculum

Dimensions	Main Focus	Component
Content	Mathematical concepts	Learn numbers & numerical calculations; Geometry, measurement & analysis of data and probabilities
	Mathematical processes	Problem solving, reasoning and critical thinking (including generalization, prediction, hypothesizing, guessing and testing conjectures, explaining and confirming answers, categorizing, comparing, and use of patterns), visual thinking and creative thinking (includes spatial reasoning, visual patterns, problem-solving in real and fictional story and context), mathematical discourse (including communication, mathematical reading and writing), and use of new technology in mathematics.

Source: Higher Council of Education, 2012

According to the content division in Table 1, mathematical concepts are divided into six branches: Numbers and numerical calculations, algebra and symbolic representation, geometry, measurement, statistics and probabilities, and mathematical history. Each of these concepts - in Grades 1-6 - has different levels, so educational programs and activities should be such that pupils have the ability to relate to the skills associated with each subject. The National Curriculum (2012) also emphasizes the horizontal relationship of mathematical content with other subjects. Accordingly, mathematical concepts should be taught in the context of concepts related to other scientific fields. The second part includes acquiring skills in mathematical processes. In recent years, reforms have been made to the content of math textbooks to address open-ended questions and to encourage students to explore different methods of answering. These topics have been addressed in some sections using open-ended questions and answers, problem-solving lessons, unconventional problems in mathematics, although the emphasis on the problem-solving process in content is not such that encourage discovery and innovation and develop thinking skills in learners (Reyhani, 2016).

Singapore

In this country, the main focus of content - as one of the elements of the mathematics curriculum - is on the development of competence in problem solving (Ministry of Education Singapore, 2021) (Table 1).

Table 2
Content Framework in Singapore Primary Mathematics Curriculum

Dimensions	Main focus	Component
Content	Solve math problem	Attitude: Beliefs, interest, appreciation, trust, perseverance
		Concepts: Numerical, algebraic, geometric, statistical and analytical probability, calculations
		Processes: Reasoning, Communication and Connection, Thinking Skills, Approaches, Applications and Modeling
		Skills: Ability to do numerical calculations, grammar and spatial representations, data analysis, measurement, use of mathematical tools, estimation
		Metacognition: Monitoring your thinking, self-discipline in learning

Source: Ministry of Education Singapore, 2021

The content framework of the Singapore Mathematics Curriculum consists of five interrelated components that, as a reflection of needs of the 21st century curriculum, provide a guide to teaching, learning and evaluating mathematics at all levels of education - from primary to pre-university. According to this framework, mathematical processes refer to the skills of using mathematical knowledge as an important part of the content and include reasoning, communication, applications & thinking and exploration skills that are important in solving mathematical problems and beyond. In primary school, pupils learn these skills through problem solving. They learn to work logically, to express their thoughts in writing and orally, and by using patterns and observing similarities and differences between mathematical ideas and life. In fact, problem solving as a central focus in content, in addition to strengthening mathematical skills and processes, emphasizes the development of attitudes and self-regulated learning. Also, this type of connection, with a deeper understanding of concepts, leads to the development of different mathematical ideas through exposure to a variety of useful experiences and activities. In addition, the problem-solving approach - while enhancing students' confidence and interest in

mathematics - creates an interdisciplinary approach that links mathematics to real life and other school subjects (Ministry of Education Singapore, 2021).

3- Learning-teaching strategies

Iran

According to the National Curriculum of the Islamic Republic of Iran (2012), in order to learn mathematical concepts in depth, students must act like a researcher and in the process of teaching-learning, discover how new concepts occur and how can be used with and generalized. In this program, students must be able to construct concepts during the process of solving a significant problem and play an active, voluntary, and conscious role in the teaching-learning process. The program also emphasizes the strengthening of the spirit of inquiry in teaching process to increase motivation of students - through exploration - to provide the ground for their effective interaction with the teacher, peers and learning environments (Council of Education, 2012). In the real situation, the use of active teaching-learning methods is lacking in most math classrooms in Iran, and this process is done in a traditional way with an emphasis on student memory. In the traditional method, the teacher's focus is more on explaining the contents of the book, and pupils solve problems and exercises in the ways that the teacher says. If the new lesson is related to the previous lessons, the teacher will first review the previous material and then explain the new lesson. The presentation is usually lecturing and teacher-centered. During teaching, the teacher - for example asks some questions and then solve them. Students solve book exercises - which were not available time in the classroom - at home (Seifi, 2018; hajizadeh, 2013; Navidy, 2013).

Singapore

In Singapore, the method of teaching mathematics provides opportunities for students to achieve the skills necessary for life in the 21st century. As students engage in problem-solving, reasoning, critical thinking, and communication, they discover different ways to solve a problem and to demonstrate it in the real world. This learning method helps students engage in creative thinking and learn how to articulate a problem and

manage its complexity (Ministry of Education Singapore, 2021). Math teaching methods are done in three stages of preparation, engagement and mastery in teaching:

- Readiness: identifying students' previous information;
- Engagement: student's active participation, engaging with content, discovering and understanding meanings, focusing on specific questions and ideas;
- Mastery: forcing students to practice to gain skills, using a teacher-led questioning method. At this stage, students look for appropriate methods and solutions and consolidate what they have learned by mastering the concepts. Another teaching method in the Singapore Mathematics Curriculum is to focus on learning experiences and skills development in the processes related to each mathematical subject. These experiences develop positive learning habits. In fact, students should have the opportunity to properly evaluate their learning progress using exploratory methods and organizing meaningful information. This approach, while encouraging students to acquire problem-solving skills, can also be motivating and entertaining (Ministry of Education Singapore, 2021).

4- Evaluation

Iran

In the National Curriculum of the Islamic Republic of Iran (2013), qualitative evaluation is done in three ways: Formative, diagnostic and cumulative:

- Developmental: Student's continuous growth with emphasis on self-assessment, which provides a clear and comprehensive picture of the current situation; her/his distance from the next situation and how to correct it according to her/his capacity and needs.
- Diagnostic: in order to determine the degree of understanding / misunderstanding or make scientific arrangements to solve conceptual and skill problems of students and help the growth of learning.
- Compaction: is a traditional math test that is done once or several times during the semester or academic year to assess the knowledge of learners and identify students' mathematical understanding.

In Iran, despite the emphasis on descriptive assessment in primary school and the importance of selectivity and self-management in the continuous growth of students in this course, traditional assessment is still very important in schools. Teachers use traditional methods to assess students by emphasizing book or similar problems and exercises, and there is a tendency to conduct exams in the manner of convergent and stereotype questions (Golpoushnejad, 2016; Shirazi et al., 2016). On the other hand, the performance of Iranian students in the TIMSS 2007-2019 among 58 countries was lower than the global average. For example, in the preliminary results of the TIMSS 2019, Iranian pupils ranked 50th out of 58 countries in the fourth grade math exam (Mullis et al, 2019; Shirazi et al, 2016). The repetition of these undesirable outcomes is influenced by assessment methods, and teachers' extreme emphasis on students' memorization of book content (Shirazi et al, 2016).

Singapore

In Singapore, assessment is an integral part of the interactive teaching and learning process. This continuous process gathers information about students' learning, so that while identifying learning gaps, methods can be considered to improve it. In this system, although it is necessary to know what skills the student has acquired in the learning phase, it is equally important that she/he be involved in peer assessment or self-assessment as part of the learning process (Ministry of Education Singapore, 2021). In the assessment process, students become more active in the learning process by being aware of their level of learning, while focusing on the quality of learning (Lee, 2019; Ministry of Education Singapore, 2013). In the Singaporean education system, the evaluation book is placed next to other textbooks - including mathematics - and covers all subjects and workbook activities (Caldwell, 2019). This book includes additional questions and issues, conceptual questions, questions related to learning thinking skills, reasoning and creativity, measuring higher levels of thinking, and hands-on activities. In addition to consolidating and deepening learning, the assessment method in the Singapore Mathematics Curriculum also promotes metacognition (Ministry of Education Singapore, 2013).

4) Comparison

At this stage, by summarizing components, the information examined in the previous sections are classified in terms of similarities and differences and base on elements of mathematics curriculum - goals, content, teaching-learning strategies and evaluation-, in Iran and Singapore.

1-Goals

Table 3
Comparison of Goals in the mathematics curriculum of Iran and Singapore

Goals	**Iran**	**Singapore**
Expressing goals in an ideal way	*	*
Definite commitment to the curriculum document for compiling the content of math textbooks	*	*
Focus on cognitive goals and amount of information and mathematical knowledge	*	-
importance of problem solving as a main goal of mathematics education	-	*
Development and application of metacognitive skills through problem solving approach	_	*
Special attention to attitude's goals in boosting confidence and interest in mathematics	-	*
Selection and sequencing of goals according to the characteristics of learners	-	*
Nurture mathematical ideas and create opportunities to deepen the student's understanding and knowledge	-	*
Provide mathematical concepts and skills for application in everyday life	-	*
Support the continuous learning of mathematics and connection between mathematical ideas and other subjects	-	*

According to Table 3, out of a total of 11 goals, Iran and Singapore are similar in two targets and different in the others. The most important similarity is related to the active role of the formal education system of both countries in designing the goals of mathematics education. Thus, authors and curriculum planners are required to have the approval of the Ministry of Education and to match the content of math textbooks with the national curriculum document. The most important differences of two countries can be mentioned as follows:

In Singapore, "problem solving" is the primary goal of teaching mathematics and paving the way for the growth of life skills in the 21st century. Therefore, all reasoning processes, thinking skills, approaches; numerical, algebraic, geometric, statistical concepts;

skills; attitudes and metacognition are related to a general goal, that is "problem solving". This strategy should prepare students for acceptance of out-of-school living conditions - which require the selection and use of appropriate concepts and skills. In Iran, “problem solving” is considered as one of the goals of an independent process and therefore it has been considered to some extent in content of school textbooks.

Another important difference between Iran and Singapore is the focus on "attitude". Mathematical goals in Iran focus more on cognitive goals and amount of information and knowledge and less attention is paid to attitudinal goals in mathematics, but in Singapore, strengthening self-confidence, belief and positive attitude towards mathematics in students and teachers is important. This attitude helps to keep people in the mood and to use math to solve problems. In Singapore, believing in and appreciating the value of mathematics has increased one's confidence and motivation to use this science, and has created an interest and perseverance in solving life problems using mathematics. Other differences between the two countries include levels of goals - taking into account the characteristics of learners. In Iran, the goals in terms of structure and content are set equally for all students, but in Singapore, the breadth and depth of math education goals change at each stage, depending on the ability, interest, and confidence of the learners.

2. Content

According to Table 4, both countries pursue the content in mathematics curriculum which is selected, organized, and taught based on predetermined educational goals. Iran and Singapore also have some differences in the content of primary school mathematics textbooks as follow:

One of the important differences is that in Iran, content is the main axle of teaching and learning, but in Singapore the main emphasis is on learning problem-solving skills. Therefore, in this country, the teacher focuses on teaching math skills and processes to learners rather than transferring content. This shows what is expected of students in terms of processes and quality of work. Other differences between the two countries' math textbooks include sequences in content levels - according to the different needs and abilities of students. The content of math textbooks in Singapore covers fewer topics but is

taught to learners with more in-depth. Also in Iran, the content of math textbook is the same for all students on the same basis, but in Singapore, it has a spiral approach at different levels, so that advanced concepts and skills are based on basic foundations- with regards to learners' needs and abilities. This sequential gives the opportunity to pupils for use practice skills.

Table 4
Comparison of Content in the mathematics curriculum of Iran and Singapore

Content	**Iran**	**Singapore**
Determining content based on educational goals	*	*
Mathematical concepts and processes as a important parts of mathematics content	*	*
Content contains learning experiences according to level and needs of learners	-	*
Focus on content as a main core of training and learning	*	-
Organize practical programs in content	-	*
Develop understanding and application of mathematics through connection between mathematical ideas and other subjects	_	*
Content emphasis on competency development through problem solving	-	*
More emphasis on pupil metacognition development and self-regulation	-	*

Another important difference is the connection and interconnectedness of content framework. The content framework in Singapore is based on the application of the problem-solving method, which emphasizes five interrelated components - concepts, practice of mathematical skills and processes, attitudes, and metacognition. The problem-solving tasks are set up for a deep understanding of the concepts and development of various mathematical ideas. Communications and their applications expose students to a variety of learning experiences - such as useful activities and tools - to relate abstract concepts to learning experiences. This process balances content and skills. In Iran, the components of problem solving (problem design, data collection, hypothesis making, hypothesis testing and inference) do not have a balanced distribution. Therefore, due to this content, problem solving skills are not well taught.

3. Learning methods

Table 5
Comparison of learning methods in the mathematics curriculum of Iran and Singapore

Learning methods	Iran	Singapore
Support development of communication skills by creating opportunities to collaborate with each other and present own ideas	*	*
Supporting active role of student in learning methods	*	*
Emphasis on textbooks during teaching	*	-
Provide opportunities for students to develop learning skills in mathematics	-	*
Development of metacognition and self-leadership to enhance learning	-	*
Focus of training on self-directed learning in students	-	*
Teaching adequate with differences in students' learning	-	*
Attention to conceptual understanding and connection of teaching with real world	-	*

According to Table 5, Iran and Singapore are similar in supporting the active and voluntary role of students in the learning process and effective interaction with teachers, peers and school environment. Some of the most important differences between two countries in teaching and learning methods are as below:

One of the important differences between two countries is role and method of teaching. In Iran, the teacher is the source of knowledge and axis of class. The teacher begins her/his teaching by reviewing previous sessions or giving an introduction, and teaches the new content or skills. In Singapore, the trend in classrooms is learning-centric. The role of teacher is to encourage and guide pupils to take more responsibility for learning. The teaching method is based on an interactive process that focuses on student learning. In this process, teachers use a wide range of teaching methods to engage students in the learning process.

Another difference in the teaching methods of two countries is allocation of appropriate opportunities to develop self-regulatory learning habits in students. In Singapore, students are given the opportunity to collaborate with each other and present their ideas using mathematical methods. Sometimes these opportunities are the focus of practicing or solving real-world problems that are forced upon students. These exercises -

in addition to gaining skills - can be motivating and entertaining. Through this process, students have ample opportunity to strengthen their thinking skills and to deepen their understanding of mathematics by discovering new ways. In Iran, the main emphasis is on teaching the textbook during teaching - rather than providing opportunities for learning experiences for students. Therefore, students are given less opportunity to explore ways to solve problems. Another difference is attention to students' individual differences in learning. In Singapore, learners are noticed by the teacher in terms of different levels and speeds of learning. Therefore, the teacher training method is designed in such a way that students can move forward according to their abilities. In Iran, the teaching method is applied equally to all students.

4. Assessment

Table 6
Comparison of Assessment methods in the mathematics curriculum of Iran and Singapore

Assessment	**Iran**	**Singapore**
Assessment as an integral part of teaching and learning process	*	*
Purpose of assessment is to measure learning ability	*	-
Assessment helps students improve their learning	-	*
Attention to external evaluations to match qualifications needed to live in the new century	-	*
Evaluation as a structural tool for providing qualitative feedback	-	*
Emphasis on memorizing and designing convergent questions	*	-
Set meaningful and operational tasks in evaluation	-	*
Emphasis on peer assessment or self-assessment as part of learning process	_	*

In Iran and Singapore, assessment is important to identify and determine students' learning. Continuing assessment during class activities is also important in both countries. There are also differences in the way the two countries evaluate: Assessment in Singapore is an essential part of the interactive teaching and learning process. In this ongoing process, teachers gather information about student learning to support effective teaching. These rich and timely feedbacks show what stage students are at and what needs to be done to

improve their learning. In Iran, evaluation means measuring the level of learning ability in students and is less done to identify the quality of learning.

One of the differences is the scope of evaluation. Evaluation is more widespread in Singapore and is not easily implemented through traditional methods. In this country, the method of evaluating classroom activities is integrated in different ways. Teachers use divergent and responsive questions, and students are assessed through qualitative feedback - such as doing a skill, judging an idea, developing a story, or evaluating how they are learning. Integrating performance appraisal into the learning process provides students with new learning experiences. In Iran, this breadth and depth does not exist in the way of qualitative feedback and the evaluation system mainly tends to use traditional tests and convergent questions.

Another difference between the evaluation systems of selected countries is the effect of evaluation on students' self-esteem. In Singapore, further assessment focuses on creating learning opportunities and students' reflection on how to improve their learning. For this reason, the assessment method influences students' learning motivation and makes them aware of their strengths and weaknesses. This assessment method strengthens learners' confidence and interest in learning mathematics. In Iran, the results of assessments are more important than the assessment process and therefore assessment is more focused on identifying students' knowledge performance and determining whether their answers are correct or incorrect.

4. Conclusion

One method to develop and rebuild an educational program is to use successful experiences of different educational systems. Also, attention to the similarities and differences in curriculum’s structure is essential for development of education. In main goal of present study was considering the most important points of similarities and differences in mathematics curriculum dimensions of Iran and Singapore. The results can be examined from the perspective of different indicators:

The first research finding highlighted that the most common aspects of mathematics curriculum in two countries is related to the goals. One of the common goals of the Iran-Singapore Mathematics Curriculum is to transform and achieve some of the basic

competencies in developing thinking skills and creative activities. The main differences between selected countries in the goals of Mathematics education are related to supporting the growth of the acquired competencies needed to live in the 21st century and methods of understanding and applying mathematics to develop metacognition and self-direction.

Another fundamental difference between two educational systems is position of the "problem solving" skill in the mathematics education process. As a specific process goal in math curriculum, Singapore has been able to take math learning to a higher level by emphasizing learning "problem solving" skills. In fact, the goal is not just to teach problem-solving skills, but to create coherence between content and skills, and to be careful and focused on the steps to arrive at an answer - like a mathematician - that strengthens thinking skills and discovery of great ideas. Learning occurs through focus, spending more time, and trying to understand the subject in depth - not just looking at a large number of topics - (CCSSI, 2014). In this regard, Reyhani, Ahmadi, & Karami Zarandi (2010) point out that problem solving is valuable when one knows what steps has taken to arrive at an answer and what the reason is. On the other hand, by increasing the emphasis on problem-solving skills, students gain the ability to formulate, represent, and solve mathematical problems in relation to topics inside and outside of mathematics. It also helps them experience more diversity and creativity in an active learning environment. This finding is in line with research finding of Coffland & Xie (2015) who stated that special attention to the processes in the mathematics curriculum depends on the knowledge, skills and attitudes that students gain from learning mathematics in school. In addition to understanding and applying content, these processes can improve mental development and enhance creativity in learners. In Iran, training of "problem solving" skills still does not have a special place in the national document as well as teacher teaching methods. It seems that in order to change teaching methods, in addition to improving the beliefs and attitudes of teachers, it is necessary to change the views of students, parents, curriculum planners and public.

Another finding of the present study is flexibility in leveling the goals of Singapore Mathematics Education, which provides meaningful learning opportunities for students to improve skills and abilities according to their interests and talents. This different approach

gives them the opportunity to design different strategies for solving a problem and to learn how can manage ambiguity and complexity in the real world by simplifying problems. Research by Hollenbeck, Wray & Fey (2010) and Weber, Inglis & Mejia-Ramos (2014) also showed that when people understand the mathematical connection to real situations will continue to learn it in the future to provide the opportunity to learn mathematics in their areas of interest. Thus, the Singaporean education system, by cultivating a set of socio-emotional skills, values, and competencies, employs a framework in its mathematics education that directs students' interest in the quality of education identifies and applies.

The research findings also confirm this fact that despite lack of attention to the scope of attitudes in goals of Iran Mathematics curriculum, cultivating a positive attitude towards mathematics has strengthened the confidence of learners in Singapore. Singaporean pupils also have different starting points in learning content, so the math curriculum provides different paths and choices to support each student to maximize learning motivation. This can provide a meaningful perspective on the joy of learning for students and pave the way for their success and metacognitive development. On the other hand, according to the research findings, combining performance appraisals in education and avoiding focusing on score results in Singapore reduced stress in students and increased their interest in learning. Thus, the performance of Singaporean students at the international level has led to successive successes in achieving superior results in the international exams of TIMSS & PISA. This finding is in line with finding of Shirazi et al. (2016) who, while pointing to the poor performance of Iranian students in international exams such as TIMSS, emphasize that there is a direct relationship between a positive attitude towards the subject and students' performance.

It is also inferred from the research by Lahdemaki (2019) and Youkhanaa, Leifkesb, & Enrique. (2018) that one of the reasons for decrease in interest in learning and loss of creativity is using inappropriate methods in evaluation. Singapore's education system, by taking initiatives and focusing on the quality of learning and providing a student-centered learning model, has been able to stimulate learners' desire to learn mathematics. Despite succeeding in international exams, this education system is still evolving to prepare students for the more complex socio-economic environment of the 21st century, while

continuing to be able and willing to meet emerging demands of the knowledge-based global economy. In fact, Singapore's education policy focuses on the growth of human resources and seeks to familiarize students with the country's cultural, economic and social needs in order to provide them with the skills needed to meet those needs. According to the research findings, the need to change the structure of the mathematics curriculum in primary schools of Iran is evident. One of these priorities is to use a coherent, continuous and relevant process in the mathematics education program that emphasizes teaching "problem solving" skills and using themes to acquire life skills needed in the 21st century. It is also suggested that the training of math teachers to use new teaching methods, new teaching tools and optimize their skills to assess students' learning should be considered by curriculum planners. The math curriculum needs to be revised so that the classroom becomes a place that brings students closer to understanding and applying mathematics.

References

Abramovich, S., Grinshpan, A. Z., & Milligan, D. L. (2019). Teaching Mathematics through Concept Motivation and Action Learning, *Journal of Education Research International*, 1-14, Available at: https://doi.org/10.1155/2019/3745406

Alamian, V. (2012). *Grade 1 math teacher guide*, Tehran: Educational Research and Planning Organization, [In Persian].

Al-Jaafari, A. (2017). *A look at the top five educational systems in the world*, Al- Bayan Center for Planning and Studies, 12-24, [In Persian]

Askari, M., Elahimanesh, M. H., & Parizad, R, (2019). A Comparison Study of Iranian and Japanese educational policy at primary level, *Strategic Studies of Public Policy*, 9(30), 113-132 [In Persian]

Azizi Mahmoudabad, M., & Nili, M. R. (2019). Evaluation of primary school math curriculum, *New Educational Ideas*, 15(2), 1-24, Available at: https://civilica.com/doc/1013532, [In Persian]

Bakhshalizadeh, Sh., & Broojerdian, N. (2017). Identifying common misunderstandings of fourth grade primary students in the field of geometry content and measuring and comparing their performance with the average performance at the international level, *Journal of Educational Innovations*, 16(64),101- 126, [In Persian]

Borel, A. (2017). *Mathematics: art and science*, European Mathematical Society Newsletter, 103, 37–45.

Brezovnik, A. (2015). The benefits of fine art integration into mathematics in primary school, *CEPS Journal*, 5(3), 11-32, available at: https://files.eric.ed.gov/fulltext/EJ1128967.pdf

Caldwell, J. (2019). Primary School Education: Preparing Your Child for Tomorrow, 1-10 , Available at: https://www.readkong.com/page/primary-school-education-preparing-your-child-for-tomorrow-8231703

Coffland, D.A., & Xie, Y. (2015). The 21st Century Mathematics Curriculum: A Technology Enhanced Experience, 5-17. In X. Ge, D. Ifenthaler, J.M. Spector (Eds.), Full Steam Ahead: Emerging Technologies for STEAM: Springer

Common Core State Standards Initiative, (2014). *Key Shifts in Mathematics*, Available at: http://www.corestandards.org/other-resources/key-shifts-in-mathematics/

Dehghani, M., & Safdari, K. (2017). Degree of adaptation of mathematics curriculum based on the goal setting pattern of the national curriculum in primary schools, *First National Conference on Educational Sciences & Psychology*, Marvdasht, June 2-3, Available at: https://civilica.com/doc/338879 [In Persian].

Deng, Z., Gopinathan, S., & Lee, C. K. E. (2013). *Globalization and the Singapore curriculum: From policy to classroom*. Singapore: Springer.

DeRosa, J. (2017). *STEAM Curriculum: Arts Education as an Integral Part of Interdisciplinary Learning.* 30-77. Available at: https://mosaic.messiah.edu/gredu_st/11.

Elmore, R. (2004). *School reform from the inside out: Policy, Practice, and Performance*. ERIC Collection, Available at: https://eric.ed.gov/?id=ED568807

Esmonde, I., Blair, K. P., Goldman, S., Martin, L., Jimenez, O., & Pea, R. (2013). Math I am: What we learn from stories that people tell about math in their lives. In B. Bevan, P. Bell, R. Stevens, & A. Razfar (Eds.), *Lost opportunities: Learning in out of school time*. pp. 7–27, available at: http://life-slc.org/docs/Esmonde_MathIAm_2011.pdf

Finn, V. K. (2010). Inductive method of joint agreement-difference: Procedural semantics of the JSM method. *Automatic Documentation and Mathematical Linguistics*, 44(2), 68-88.

Fullan, M. (2006). *Change theory: A force for school improvement. Centre for Strategic Education*, Series 3-14, available at: http://michaelfullan.ca/wp-content/uploads/2016/06/13396072630.pdf

Kaur, B. (2013). Math Education in Singapore, Translated by Shala Gholam Azad, Roshd : Journal of Math Education, 2(30), 4-10 [In Persian]

Gholam Azad, S., Gooya, Z. (2016). Development of an Interdisciplinary Curriculum at the Graduate Level: Master and Doctoral Program of Mathematics Education in Iran, *Journal of Higher Education Curriculum Studies*, 7(14), 33 -52, [In Persian]

Gooya, Z. (2011). A critical review of the Newly Proposed National Curriculum of Iran with emphasis on the Mathematics Curriculum, *Journal of Curriculum Studies*,18(5), 150-159, [In Persian]

Golpoushnejad, M. (2016). A Comparative Study of Math Education in Iran and Australia: Reviews Different Mathematical Topics, *M.A. Thesis*, Islamic Azad University of Marvdasht

Hallinger, P. (2005). Instructional leadership and the school principal: A passing fancy that refuses to fade away, *Leadership and Policy in Schools*, 4(3), 221–239.

Hollenbeck, R. M., Wray, J. A., & Fey, J. T. (2010). Technology and the teaching of mathematics, In B. J. Reys, R. E. Reys, & R. Rubenstein (Eds.), *Mathematics curriculum: Issues, trends, and future directions*. pp. 265–276. Reston: National Council of Teachers of Mathematics.

Kasyani, N., Zarei, H. A. (2019). Relationship of reading literacy to math and science performance in female students in the TIMSS test, *Journal of Psychological Science*, 74(18), 257-264, [In Persian]

Lähdemäki, J. (2019). Case Study: The Finnish National Curriculum 2016—A Co-created National Education Policy. In: Cook, J. (eds) *Sustainability, Human Well-Being, and the Future of Education*. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-78580-6_13.

Lee, J. (2019). *Curriculum in Primary Education (Singapore),* National Institute of Education (NIE), 1-7, available at: https://www.researchgate.net/publication/332050527_Curriculum_in_Primary_Education_Singapore

Leithwood, K., Louis, K. S., Anderson, S., & Wahlstrom, K. (2004). *Review of Research: How Leadership Influences Student Learning*. University of Minnesota, Center for Applied Research and Educational Improvement, Retrieved from the University of Minnesota Digital Conservancy, https://hdl.handle.net/11299/2035

Liao, C. (2016). From interdisciplinary to transdisciplinary: An arts integrated approach to STEAM education, *Journal of Art Education*, 69(6), 44-49, 10.1080/00043125.2016.1224873

Minaei, A. Delavar, A. Filsafinezhad, M. R. Kiamanesh, A. R. Mohajer, Y. (2013). Cognitive Diagnostic Modeling of Iranian Grade 8 student to Mathematics Items of TIMSS 2007 Using an integrated model with reprocessing (1 RUM)& comparison between girls and boys, *Quarterly Journal of Educational Measurement*, 4(16), 139-140, [In Persian]

Ministry of Education Singapore, (2013). *Primary Mathematics: Mathematics Syllabus Primary One to Six*, Ministry of Education, available at: https://www.moe.gov.sg/-/media/files/primary/mathematics_syllabus_primary_1_to_6.pdf

Ministry of Education Singapore: (MOE). (2021). *Primary Mathematics: Mathematics Syllabus Primary One to Six*, Ministry of Education, available at: https://www.moe.gov.sg/-/media/files/syllabus/2021-pri-mathematics.ashx?la=en&hash=261370741B22DBC096C3EFF5632DB1CB7757A209

Ministry of Education Singapore: (MOE). (2010). Nurturing our young for the future: Competencies for the 21stcentury, Available at: https://bioquest.org/nie2011/wp-content/uploads/2011/07/nurturing-our-young1.pdf

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). *TIMSS 2019 International Results in Mathematics and Science*, Retrieved from Boston College, TIMSS & PIRLS International Study Center website: https://timssandpirls.bc.edu/timss2019/international-results/

Battelle for Kids.org, (2014). *Framework for 21st century learning*, Battelle for Kids.org, Available at: https://static.battelleforkids.org/documents/p21/P21_Framework_Brief.pdf

Pea, R., & Martin, L. (2010). Values that Occasion and Guide Mathematics in the Family, *Teachers College Record*, 112(13), 34–52. https://doi.org/10.1177/016146811011201303

Rafiepour, G. A., Gooya, Z. (2010). The Necessity and Direction of Educational Changes in Iran's School Mathematics Curriculum from Teachers Viewpoints, *Journal of Educational Innovations*, 33(9), 91-120 [In Persian]

Reyhani, I., (2016). *Lines analysis, approved documents, research and reliable sources related to the field of mathematical learning*, Ministry of Education, available at: https://bayanbox.ir/view/8036895771013107495,[In Persian]

Reyhani, I., Ahmady, Z., Karami-Zarandi, Z. (2010). A Comparative Study of Teaching Problem Solving Process in High School Math Curriculums of the United States, Australia, Japan, Singapore, and Iran, *Quarterly Journal of Education*, 1(27), 117-140, [In Persian]

Salsabili, N. (2017). Assessing the Islamic Republic of Iran's National Curriculum on the base of criteria derived from theoretical foundation of the curriculum field, *Journal of Curriculum Studies,* 11(41), 65-70,[In Persian]

Schoenfeld, A. (2004). The math wars, *Journal of Educational Policy*, 18(1), 253–286

Schoenfeld, A. (2007). Problem solving in the United States, 1970–2008: Research and theory, Practice and Politics. *ZDM*: the international journal on mathematics education 39(5):537-551, available at: https://www.researchgate.net/publication/225643988_Problem_solving_in_the_United_States_1970-2008_Research_and_theory_practice_and_politics

Seifi, A. (2018). Primary Teaching Methods, The First National Conference on New Findings in the Field of Teaching and Learning, Available at: https://civilica.com/doc/865123, [In Persian].

Shahbazi, Sh. Nourian, M. (2015). A Comparative Study of High Schools in Iran and Sweden: Case Study of Atomic Energy High School in Iran & Sweden Global School, *Journal of Curriculum Development & Educational Planning Research*, 4(1),101-103, [In Persian].

Shekarbaghani, A. (2012). Singapore Physics Education System Structure and Curriculum, *Roshd: Journal of Physics Education,* 28(2), 52-58, [In Persian].

Shirazi, M. Ali Sufi, A. Jalili, M. Badpa, K. Khashi, A. (2016). Mathematical Education in the Mirror of TIMSS International Studies, *Third Conference on Psychology, Educational Sciences and Lifestyle with International Approach*, Mashad City, May 3-7 May, 5-10, [In Persian].

Supreme Council of Cultural Revolution, (2011). Document of Fundamental Transformation of Iran's Education, Tehran: Ministry of Education. Available at: https:// www. medu.ir /fa/news/item/663196, [In Persian]

Higher Council of Education. (2012). National Curriculum of the Islamic Republic of Iran, Tehran: Ministry of Education. Available at: http:// mebtedaei.yazdedu.ir /documents /110271/0, [In Persian]

UNESCO-IBE, (2007). *Singapore, Principles and general objectives of education*, World Data on Education, available at: http://www.ibe.unesco.org/sites/default/files/Singapore.pdf

Weber, I., & Mejia-Ramos J. P. (2014). How mathematicians obtain conviction: Implications for mathematics instruction and research on epistemic cognition. *Educational Psychologist*, 49(1), 36–58

Wiggins, G., & McTighe, J. (2005). *Understanding by design*, Upper Saddle River: Pearson.

Willoughby, S. (2010). Reflections on five decades of curriculum controversies, In B. J. Reys, R. E. Reys, & R. Rubenstein (Eds.), *Mathematics curriculum: Issues, trends, and future directions*. pp. 77–85. Reston: National Council of Teachers of Mathematics.

Wong, B. Hairon, S., Tee, N. P., (2019). School Leadership and Educational Change in Singapore, Springer Texts in Education

Yakman, G. (2012). Exploring the exemplary STEAM education in the U.S. as a practical education framework for Korea, *Korea Association Science Education*, 32(6), 1072-1086

Yazdani, J., & Hassani, M. (2011). A Study on the Level of Conformity between Curriculum Guidelines' Goals at the Primary and Middle School and Formal Objectives of the Higher Council of Education, Journal of Curriculum Studies , 20(6), 58-79, [In Persian]

Youkhanaa, E., Leifkesb, C., & Enrique, T. (2018). Epistemic Marginality, Higher and Environmental Education in Colombia, *Gestión y Ambiente*, 21(2), 15-29, available at: file:///C:/Users/seven/Desktop/Downloads/77752-Texto%20del%20art%C3%ADculo-415387-2-10-20190508.pdf