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# Examining Changes Between China's 2001 and 2011 Mathematics Curriculum Standards for Basic Education From 21st Century Key Competencies Perspective

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## Abstract

In the Western developed world, the language of 21st century key competencies, also referred to as 21st century competencies, 21st century skills or key competences, is a powerful means of drawing attention to links between the secondary school curriculum, post-secondary education and the social and economic imperatives of the developed economies. This paper will analyze different levels and breadth of meaning which serves to define 21st century competencies and skills. In particular, the paper looks at how these transformative expressions have characterized the most recent revision of China's curriculum standards for mathematics in the years of basic education.

**Key words:** Key competencies; China; Mathematics curriculum; Basic education; Information and Communication Technology (ICT)

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## INTRODUCTION

At the start of the 21st century many countries are recasting their understandings of economics, communication, security, cultural identity, citizenship and the environment. The new millennium was ushered in by a dramatic technological revolution. Societies are now increasingly diverse, globalized, and complex, media-saturated and information-driven. Authors such as Anderson (2008), Dede (2011) and Hala'sz and Michel (2011) also use the term "knowledge society" to characterize today's society. This expression has also been extended to characterize a "globalized knowledge society". Such an expression serves even more strongly to draw attention to the competencies and skills required for a "globalized knowledge society". Consequently, schools and educational systems around the world need to make changes to their curricula, that is, how young people are expected to learn and be taught (Organization for Economic Co-Operation and Development (OECD), 2005; Voogt and Pelgrum 2005; European Parliament, 2007; Voogt and Roblin, 2012; Griffin, McGaw and Care, 2012).

## 1. DEFINING KEY TERMS AND LEVEL OF MEANING

In current discourse about the purposes of near-universal primary and secondary education , 21st century competencies have transformed beyond knowledge and skills to involve "the ability to meet complex demands, by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context" … and as "being necessary for everyone" (OECD, 2005, p.4).

Likewise, the European Union (European Parliament, 2007) defined key competencies as those which all individuals need for personal fulfillment and development, active citizenship, social inclusion, and employment. These definitions have two important implications. First, they draw attention to skills or competencies that are important across multiple areas of life and that contribute to an overall successful life and to a well-functioning society. Second, they

recognize that the key competencies depend on what societies currently value in an increasingly globalized environment.

Competencies, in these senses, denote intellectual abilities, that is, an individual's general cognitive and dispositional resources for mastering challenging tasks across different contexts, acquiring the necessary knowledge, and achieving high performance. After reviewing the international literature on 21st century competencies, we argue that it is essential to distinguish several distinct levels:

Level 1 competencies which apply very generally to school education, such as:

- "Learning to learn" (European Union, 2006)
- "Functioning in socially heterogeneous groups including the ability to manage and resolve conflicts" (OECD, 2005)
- "Use new technologies and cope with rapidly changing workplaces" (Asia-Pacific Economic Cooperation Education Reform Symposium, 2008)

Level 2 competencies tend to describe competencies that are important for teaching and learning in school subjects in the period of compulsory education. These are more specific than Level 1 competencies, and might, for example, include collaboration, communication, problem solving, reasoning ament, creative and innovative thinking, and appropriate use of Information and Communications Technology (ICT). The Australian Curriculum, Reporting and Assessment Authority (2010) employs seven "general capabilities" (its expression) that are intended to apply across all areas of the curriculum: Literacy, Numeracy, ICT Capability, Critical and creative thinking, Personal and social capability, Ethical understanding, and Intercultural understanding. In regard to its Australian Curriculum: Mathematics, ACARA (2010) advocates four "proficiencies": Understanding, Fluency, Problem-solving and Reasoning. Other instances of Level 2 competencies are the Programme for International Student Assessment (PISA) capabilities for mathematics, such as communication, representation, devising strategies, mathematization, reasoning and argument, using symbolic, formal, and technical language and operations (Stacey, 2012). Some Level 2 competencies, like Communication, Collaboration, Reasoning, Problem solving, and Creative thinking, are important to many school subjects. The PISA capabilities for Mathematics contain a mix of these more general competencies and some which are specific to Mathematics.

Not so evident in the discussion of 21st century skills and competencies are what we call Level 3 technical skills which are specific to particular training programs (e.g. in technical and vocational training courses), such as the ability to operate a particular machine effectively and safely. These technical skills are not the focus of this paper.

## 2. EIGHT INFLUENTIAL FRAMEWORKS

Voogt and Roblin (2012) examined the following influential reports or frameworks dealing with 21st century competencies relating directly to the school curriculum**:**

- 21st Century skills and competences for new millennium learners (OECD, 2005)
- Key competences for lifelong learning (European Parliament, 2007)
- ICT Competency framework for teachers (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2008)
- Partnership for 21st Century skills (P21, USA, 2009)
- EnGauge (Metiri, USA, 2003)
- Assessment and Teaching of 21st Century Skills (ATCS)
- National Educational Technology Standards (International Society for Technology in Education, 2007)
- Technological Literacy Framework for the 2012 National Assessment of Educational Progress (Wested, 2010)

Three of these eight reports were developed by international bodies (EU, OECD, UNESCO). The USA and Australia are member countries of OECD countries, and are both active in UNESCO. The remaining five frameworks were developed by non-government private organizations. Some of these, like the International Society for Technology in Education, involved Australia and the USA. However, three of these five reports – those by P21, Metiri and Wested – were developed in the USA.

From these eight reports, Voogt and Roblin (2012) identified the following:

**Table 1**
**Frequency of Findings of Level 2 Competencies in Frameworks Documents**

| Level 2 Competencies mentioned in all eight frameworks | (Level 2) Competencies mentioned in most frameworks |
|---|---|
| Collaboration | Creativity |
| Communication | Critical thinking |
| ICT literacy | Problem solving |
| Social and/or cultural skills, citizenship | Develop quality products/productivity |

## 3. POLICY PARALLELS FOR CHINA

### 3.1 Impact of Economic and School Demographic Changes

The Eighteenth National Congress in 2012 of the Communist Party of China confirmed that future economic development would be driven by: domestic demand, especially consumer demand, by a modern service industry and strategic emerging industries, by scientific and technological progress, by a workforce of higher quality and innovation in management by resource conservation and a circular economy, and by coordinated and mutually reinforcing urban-rural development.

Labour market reforms such as these require major investment and changes in education, especially in secondary and tertiary education. During the past twenty five years of China's economic rise, significant changes have taken place in all phases of schooling. According to China's Education Statistics Year Book (2010), China's primary school enrolment between 1990 and 2010, increased marginally from 97.8% to 99.7% However, in the same period, substantial changes occurred in junior and senior high school enrolments, with the promotion rate of primary school graduates (i.e. the proportion of students proceeding to junior high school) increasing from 77.7% in 1991 to 98.7% in 2010. In 2010, there were 54.1 thousand government-funded junior secondary schools (including 54 vocational ones) with about 50.7 million students and 3.5 million teachers in 2011. This represents an increase of about 10 million students from 1991. Even more dramatic has been the promotion rate from junior high to senior school. This has increased from 42.6% in 1991 to 87.5% in 2010, almost double the proportion of 1991. While similar changes have been occurring in other fast developing economies, the magnitude of these changes in China and the consequent need to re-think the purposes of schooling are apparent.

### 3.2 Policy Implications

China's national curriculum follows a ten-year cycle of implementation and review leading to a revised program for basic education. The impact of the economic and school demographic changes is therefore expected to have a major influence on how the school curriculum is framed.

Since China is itself a member country of UNESCO and the Asia Pacific Economic Consortium, one is not surprised that Chinese policy makers are attuned to the need for educational reform and receptive to the need for broad educational change as expressed in the Level 1 competencies, as described above. Within China, it is readily accepted that educational development should focus on providing human resources to meet the needs of economic and social development and overall improvement of China's population.

For example, the Outline of China's National Plan for Medium and Long-Term Education Reform and Development (2010-2020) stated that "Education in China is still not adapting to the national economy and social development and people's requirements for acquiring better education." The document cited several problems such as "regional imbalances of education development; and lagging behind for the poor areas and ethnic minorities regions" (p.7). On the other hand, the document advocated "taking reform and innovation as an impetus; enhancing equity as the national basic educational policy; enacting the overall quality education and raising quality as the core task of education reform and development" (p.7) (Translated from People's Daily by Xinhua News Agency, Beijing, 31 July 2010). The authors of the above Outline went on to re-assert that education is the key to improving people's quality of life. This does not explain why that country's curriculum writers should have picked up so precisely the language of the Level 2 competencies, as appears to be the case. In order to take this argument further, the following six Level 2 competencies were used in a document analysis examining changes between China's 2001 and 2011 Mathematics Curriculum Standards. Using the Chinese language (*hanzi*) equivalents of Collaboration**,** Communication, Appropriate use of ICT**,** Creativity (Creative and innovative thinking), Problem solving, and Critical thinking (Reasoning and strategies), a search was carried out on their comparative frequency and contextual use in China's *National Curriculum Standards of Mathematics for Basic Education* (Ministry of Education, 2011) and its predecessor document (Ministry of Education, 2001).

## 4. COMPARING CHINA' 2001 AND 2011 CURRICULUM STANDARDS DOCUMENTS

The following section compares the frequency of use of these key terms in the two curriculum documents as a means to compare the documents themselves. Following each table there is a short elaboration of the contexts in which the terms have been used in the 2011 document.

**Table 2**
**Comparative Use of the Key Term: Collaboration**

| Curriculum 2001 | Curriculum 2011 |
|---|---|
| Altogether 14 places mention collaboration, for example: "… to practice by hand, self-exploration, collaboration and communication are the most important ways for students' mathematics learning." (Curriculum rationale: p.1) | Altogether 27 places mention this key word collaboration |

In the 2011 Standards, "Collaboration" appears the following places: Curriculum rationale: 3; Curriculum goals: 6; Curriculum contents: 1; Teaching suggestions: 11; Suggestions for assessment: 3; Suggestions for Textbook compilation: 2.

Several examples: "Apart from receptive study, practice, self-exploration, collaboration and communication are equally the most important ways of learning mathematics" (p.2). "Teachers should play a leading role … and guide students to be independent in thinking, active exploration, collaboration and communication" (p.3). Students will "experience the process of solving problems by collaboration and communication with others… (p.11)" and "dare to express their own ideas, dare to question, and dare to be creative, and forming the learning habits of carefulness, hard work, independent thinking, collaboration and communication" (p.15).

**Table 3**
**Comparative Use of the Key Term: Communication**

| Curriculum 2001 | Curriculum 2011 |
|---|---|
| Altogether 20 places mention communication, for example: "these contents will be beneficial to students' actively participating in mathematical activities such as observation, experiment, communication" (Curriculum goals; p.1) | Altogether 39 places mention the key word communication (excluding key words mentioned in the appendix) |

In the 2011 Standards, "Communication" is commonly used together with the term "collaboration". "Communication" appears in the following places: Rationale: 2; Curriculum goals: 5; Curriculum contents: 9 (4 places in Number and Algebra; 4 places in Statistics and Probability; 1 place in Comprehensive Practice 1); Teaching suggestions: 10; Suggestions for assessment: 6; Suggestions for Textbook compilation: 3; Suggestions for resources development and utilization: 4.

Some instances: "Through simple data analysis, students gain experience in communicating by utilizing data" (p.19). "Teachers should guide students through practice, thinking, exploration, communication etc. and have them acquire basic mathematics knowledge, basic skills, basic ideas, and basic experience of activities (p.42) … inspiring their learning interests and by independent thinking and collaboration and communication, to comprehend basic ideas of mathematics" (p.43). "… to lead students to choose appropriate strategies by communicating with their classmates" (p.50).

**Table 4**
**Comparative Use of the Key Term: Information and Communication Technology (ICT)**

| Curriculum 2001 | Curriculum 2011 |
|---|---|
| Only 3 places mention the key word ICT.<br>"Modern ICT brings about great impacts to the value, goals, contents of mathematics education … take ICT as students' powerful tools for mathematics learning and problem solving…" (Curriculum rationale, p.1) | Altogether 22 places mention the key word ICT (not including one heading) |

In the 2011 Standards, references to "ICT" appear in the following places: Foreword: 1; Rationale: 5; Teaching suggestions: 6; Suggestions for Textbook compilation: 10.

Some specific quotations: "The development of ICT has a great impact on the value of mathematics education, objectives, content and teaching methods. The design and implementation of the mathematics curriculum should be based on the actual situation of reasonable use of modern ICT, and pay attention to the integration of ICT with curriculum content, and their effectiveness…fully consider the mathematics learning ways and contents that the ICT will have an impact on…taking modern ICT as powerful tools for students' mathematics learning and problem-solving" (p.3).

Essentially, ICT is one important way of changing mathematics learning. As for developing and utilizing ICT, teachers need to pay close attention to ICT as a complementary tool for mathematics teaching, practice and research, and taking ICT as students' complementary tools for the activities of mathematics learning (p.69).

**Table 5**
**Comparative Use of the Key Term: Creativity and Innovation (Creativity)**

| Curriculum 2001 | Curriculum 2011 |
|---|---|
| In only one instance is this key word mentioned:<br>"To have initial spirits of creativity and innovation…" (Curriculum goals, p.6) | Altogether 18 places mention the key words creativity and innovation (excluding one mention in the appendix) |

In the 2011 Standards, "Creativity" appears in the following places: Foreword: 1; Curriculum Nature: 1; Thread for the Curriculum Design: 7; Curriculum goals: 2; Suggestions for curriculum implementation: 3;

Suggestions for curriculum assessment: 1; Suggestions for textbook compilations: 3.

Some specific quotations: "Creative and innovative awareness is the basic task of modern mathematics education … Students discovering and raising questions themselves are the basis of creativity. Thinking independently and learning to think are at the core of creativity" (p.7). "Creative and innovative awareness should start from the stage of compulsory education, and it should run through mathematics education all the time" (p.7). "Teachers should transfer the basic rationale into their own teaching behaviors … inspire students' learning potentiality, and encourage them to dare to be creative and innovative" (p.42). Creative and innovative awareness is one of the core contents for textbook compilation" (p. 61).

**Table 6**
**Comparative Use of the Key Term: Problem Solving**

| Curriculum 2001 | Curriculum 2011 |
|---|---|
| 23 places mention the key word problem solving | 45 places mention the key word problem-solving |

In the 2011 Standards, "Problem solving" appears in the following places: Curriculum rationale: 1; Thread for the Curriculum Design: 5; Curriculum goals: 15; Curriculum contents: 5; Suggestions for teaching: 8; Suggestions for curriculum assessment: 3; Suggestions for textbook compilation: 5; Suggestions for resources development and utilization: 3.

Some specific quotations: "Students will acquire some basic methods of problem analysis and problem solving, and experience the diversity of methods for problem solving" (p.9). "Students will experience the process of problem solving by collaborating and communicating with others" (p.11). "In classroom teaching, teachers should encourage and advocate the diversity of strategies for problem solving, and … evaluate students' different levels in the process of problem solving" (p.50).

**Table 7**
**Comparative Use of the Key Term: Reasoning and Strategies (Critical Thinking) Reasoning**

| Curriculum 2001 | Curriculum 2011 |
|---|---|
| In 29 instances the key word mentioned: "…to utilize knowledge and methods learned to seek for strategies of problem-solving. (p. 3) | In 45 instances the key word reasoning is mentioned |
| Strategies | |
| **Curriculum 2001** | **Curriculum 2011** |
| In only one instance is this key word mentioned: "…to utilize knowledge and methods learned to seek for strategies of problem-solving. (p. 3) | In 6 instances the key word strategies is mentioned |

In the 2011 Standards, "Reasoning" appears in the following places: Forewords: 15; Curriculum goals: 7; Suggestions for teaching: 14; Suggestions for curriculum assessment: 1; Suggestions for textbook compilation: 8.

"Strategies" appears in the following places: Suggestions for curriculum implementation: 3; Suggestions for curriculum assessment: 2; Suggestions for resources development and utilization: 1

Some specific quotes about "reasoning": "Reasoning goes around the whole process of mathematics teaching, and the formation and improvement of reasoning competency will need a long-term and step by step process…" (p.50). "…let students experience the formation and application of knowledge through test, conjecture, reasoning, communication and self-reflection" (p.64).

Some specific quotes about "strategies": "Teachers should encourage and advocate the diversity of strategies to solve problems…to put forward strategies of solving problems individually and to guide students to choose appropriate strategies through communicating with others" (p.50). "Whether students can put forward strategies to solve problems … students' strategies of solving problems may be different from what teachers have pre-set (i.e. pre-determined). Teachers should give appropriate evaluation" (p.55). "(Students) forming basic strategies and ways to solve problems by searching information in internet" (p.69).

## 5. REFLECTING ON THESE DIFFERENCES

Could these six instances of increased frequency be explained by a longer 2011 Standards document? A longer 2011 document might account in part for the numerical differences. A first task is to compare the lengths of the two documents. A second is to ask whether both documents treat identical areas of Curriculum Content. A third is to compare the Curriculum Objectives of the two documents.

Both documents consist of four main parts: Introduction, Curriculum Objectives, Curriculum Content, and Suggestions on Implementation. The first three chapters in the 2001 document comprise 49 pages, whereas the same three parts of the 2011 document comprise 41 pages, making the 2001 document longer. Furthermore, the fourth chapter on Suggestions for Implementation is also longer for 2001 document (pp.51-100) than for the 2011 document (pp.42-67). Overall, the 2011 document is shorter than the 2001 document.

Secondly, three major areas of Curriculum Content are common to both documents. These are Number and Algebra, Space and Shapes, and Statistics and Probability. In the 2011 document, Statistics are named first, whereas in 2001, the order was reversed. Compared with 2001 document, some minor areas of content are omitted or rearranged in 2011 document by reducing, for example,

requirements on computations and on the number of formulas. Requirements for geometry are also reduced, with some theorems on Euclidean Geometry, previously set for years 7-9, being moved to years 10-12.

The 2001 document had only two explicit Curriculum Objectives: basic (mathematical) knowledge and basic (mathematical) skills. The 2011 document includes two more objectives: basic mathematical experience and basic mathematical thinking. The inclusion of these latter two objectives clearly permits far greater scope to focus on 21st century competencies.

## CONCLUSION

Embedded in the language of 21st Century competencies in China's 2011 Curriculum Standards in Mathematics, the role of active experience by students is more heavily emphasized. More clearly than in the 2001 document, students are recognized as legitimate creators of knowledge and so able to contribute directly and collectively each other's learning. Being linked so clearly to the 21st Century competencies, China's 2011 Curriculum Standards express clear implications for: how mathematics are taught and learned; how textbooks and other resources are compiled to support these new approaches; and how mathematics learning is valued and assessed. It remains to be seen how quickly and to what extent these implications, clearly expressed in the 2011 curriculum documents, become translated into practice—in the classroom, in textbook preparation and in assessment. The powerful influence of China's current end-of-high school assessment (*gao kao*) and the prevalence of assessment for selection purposes in earlier stages of schooling are likely to exert pressures in more conservative directions.

A possible limitation of the methodology used in this paper is its reliance on "word count", or more accurately on matching the same Chinese characters (*hanzi*) between the two documents. English speakers may wonder if different words might have been used in the 2001 to describe the same things and that these may not have been picked up in our analysis. In reply, it can be explained that, while synonyms may look different in English, in Chinese script (*hanzi*) synonyms typically embody one or more identical characters, thereby reducing this risk. What is also persuasive is the magnitude of the differences identified between the two documents.

The key ideas relating to 21st Century competencies appear to originate, as Voogt and Roblin (2010) imply, from policy documents developed in the USA, the European Union or agencies such as UNESCO. How do we explain the evident traction or adoption of these same ideas by authors of China's 2011 *Curriculum Standards for Basic Education*? It is too simplistic to point to the Western origins of these key orienting ideas without identifying parallel sources in current Chinese educational policy documents. That question has not been resolved in this analysis and remains to be done.

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