International Journal of Education and Practice
2020 Vol. 8, No. 1, pp. 57-71.
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/journal.61.2020.81.57.71

REALISTIC MATHEMATICS EDUCATION IN VIETNAM: RECENT POLICIES AND PRACTICES

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Article History
Received: 23 October 2019
Revised: 27 November 2019
Accepted: 2 January 2020
Published: 10 February 2020

Keywords
Realistic Mathematics Education
Analytical framework for RME
Mathematic education policy
Mathematics curriculum
General education
Vietnam.

ABSTRACT

The aims of this study are two-fold. First, the existing literature is reviewed to establish a framework with which to evaluate the evolution of Realistic Mathematics Education (RME) in terms of policies and practices. The framework comprises four factors: (i) national vision and strategy; (ii) curriculum and educational materials; (iii) tests and examinations; and (iv) teacher training programs. Second, this framework was used to analyze RME implementation in Vietnam, based on data obtained from document analysis and participant observation. From the experiences of other countries, several sustainable and suitable guidelines are proposed for the further practical and efficient application of RME in Vietnam. This study also outlines some possible directions for future RME research.

Contribution/Originality: This study contributes to the existing literature by: (i) introducing an analytical framework with which to evaluate RME in terms of policies and practices; and (ii) demonstrating the application of that framework to RME in Vietnam.

1. INTRODUCTION

Realistic Mathematics Education (RME) emerged due to the number of students experiencing difficulty with mathematics and applying it to the real world. First established in the 1970s by Hans Freudenthal and his colleagues in the Netherlands (Van Den Heuvel-Panhuizen, 2003), RME proved an effective method in helping both able students and slow learners to better understand abstract mathematical concepts (Sembiring *et al.*, 2008; Makonye, 2017), as well as encouraging them to actively participate in their lessons; moreover, it creates greater curricular flexibility (Sembiring *et al.*, 2008; Revina and Leung, 2019).

The 1970s witnessed increasing concern over the importance of mathematics education globally, which resulted in a "new wave" of reform in mathematical teaching. Teachers have abandoned so-called mechanistic and unrealistic teaching methods to experiment with alternative practices (Niss, 1996). Developed countries, such as the

Netherlands, Denmark, the USA, and Japan, have not only followed this trend but also raced to find the best way in which to teach mathematics (Lestari and Surya, 2017).

RME was introduced against this background, and quickly became predominant across the Netherlands. Widely recognized as an effective educational method, it was adopted in both developed, such as the USA (Nicol and Crespo, 2006) and developing, such as Indonesia, countries (Sembiring *et al.*, 2008). As a result, researchers worldwide have paid close attention to RME, even in those countries in which outstanding performances in mathematics education and mathematics in general already existed, such as Taiwan (Chen *et al.*, 2011).

Introduced to Vietnam in the mid-2000s by two oversea Vietnamese Ph.D. candidates (see (Nguyen, 2005; Le, 2006)), RME has had a significant influence in Vietnam's formal and non-formal education system during the second half of the 2010s. However, the debate about different mathematical teaching methods has grown following the recent change in policy related to a new mathematics curriculum and greater autonomy in syllabus design for local education authorities and schools (Vietnam National Assembly, 2014; VMET, 2018), in addition to international motivations. At a national level, the chief editor of the new mathematics curriculum, Prof. Do Duc Thai, stated that mathematics should be able to help students become smarter, make more money, and survive (see Thuy (2019a)). Moreover, a suitable approach to teaching mathematics could improve the Vietnamese students' understanding of the subject (Nguyen, 2018). With regard to international motivations, the Sustainable Development Goals (SDGs) (United Nations, 2015) state that education enables the achievement of other objectives; thus, an effective method for achieving basic numeracy should be the main concern of the Vietnamese government over the next few years. Overall, the Vietnamese policymakers have increasingly emphasized the importance of realistic and practical mathematical knowledge in response to both international and national pressures. In this context, RME appears to be a promising solution for Vietnam; however, there is surprisingly little literature on the topic. Although numerous studies have investigated the application of RME in different contexts and educational levels in other countries, little interest has been shown by researchers and educators in Vietnam. This study, therefore, aims to take the first step toward bridging this gap: based on preliminary data and observations on Vietnamese education, dating back to the mid-2000s, a broad view will be obtained from the following research questions:

i. To what extent is RME regulated by current policies in Vietnam?
ii. To what extent is RME implemented actual educational practice in Vietnam?

The paper is structured as follows: Section 2 provides an overview of RME and its theoretical basis; Section 3 introduces a framework for analyzing the implementation of RME comprising four components—(i) ational vision and strategy, (ii) curriculum and educational materials, (iii) tests and examinations, and (iv) teacher training program; Section 4 provides an overview of the education system and mathematics education in Vietnam; Section 5 reviews the current status of RME in Vietnam, based on the four framework components; and Section 6 offers the conclusion.

2. AN OVERVIEW OF RME

RME is based on the idea that mathematics is a human activity (Van den Heuvel-Panhuizen, 2000): the process of problem-solving, which RME educators call mathematization, is a frequent and unavoidable occurrence in life (Van den Heuvel-Panhuizen and Wijers, 2005). Therefore, Freudenthal argued that an inflexible approach should not be taken toward teaching mathematics, rather, students should be given proper guidance and actively participate in mathematizing real-life problems for themselves. As suggested in its name, reality plays an important role in RME; however, as observed in numerous studies (for instance, see (Van Den Heuvel-Panhuizen, 2003; Le, 2006)) the term "realistic" is sometimes misleading and does not entirely reflect the essence of this theory. In this context, the Dutch equivalent of the term realistic (i.e., *zich realisezen*) can be translated as "to imagine" (Van Den Heuvel-Panhuizen, 2003) thus, although RME can provide examples of problems that are not necessarily real, they

should be authentic. Others, in addition to Freudenthal, contributed to the development of RME, one of the most prominent being Treffers (1987), whose model of goal and theory description for mathematics education distinguished between horizontal and vertical mathematization. The former involves using mathematical tools to simulate then solve the problem, while the latter involves using mathematical symbols and formulas to identify and express mathematical concepts. RME integrates these two approaches to enable students to comprehend concepts by solving real-life problems. Today, after a series of modifications, there are six major principles of RME: (i) Activity—students' active participation; (ii) Reality—real-life goals and situations; (iii) Level—progressive learning; (iv) Intertwinement—integrated knowledge; (v) Interactivity—interactive learning environment; and (vi) Guidance—guided learning (Van den Heuvel-Panhuizen and Drijvers, 2014).

Understanding this development process and the core components of RME is critical in identifying RME-related issues in Vietnamese education. The literature review for this study therefore includes academic papers, legislative documents, and other relevant materials that mentioned at least one RME principle to illustrate the different extent to which RME is being applied.

3. AN ANALYTICAL FRAMEWORK FOR RME

The implementation of RME can be witnessed worldwide, but differs in extent and aspects. An analytical framework can not only assess the level of RME integration in other countries but also determine how involved Vietnamese education is in RME. The framework developed in this study comprised four distinct yet interrelated factors: first, the educational vision and strategy of a country should align with the objectives of RME (Van den Heuvel-Panhuizen and Drijvers, 2014) then the other core RME principles should be expressed in the curriculum and educational materials, tests examinations, as well as teacher training programs. This framework is depicted in Figure 1. Due to the complex nature of each country's education system, both formal and informal implementations of RME are considered in this study.

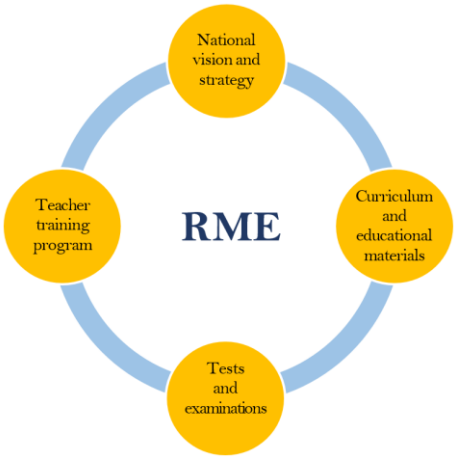

Figure-1. An analytical framework for RME.

3.1. National Vision and Strategy

Due to the realistic approach, the RME implementation is vastly different in each country (Revina and Leung, 2019) however, common features appear in their vision of and strategy for mathematics education. The national vision and strategy plays a significant role, since it determines to what extent the government invests in and prioritizes mathematics compared with other subjects. Such similarities are revealed through a brief review of the national visions and strategies of three specific countries: the Netherlands, the USA, and Indonesia. While the Netherlands provides the original working model of RME, the USA adaptation represents its integration into

developed countries, and Indonesia, which implemented RME earlier than Vietnam, is a typical developing country in Southeast Asia. Together, these three provide an overview of the adaptation and implementation of RME.

The Dutch mathematics education system is a high-profile example. To retain both freedom in education and achieve national goals, the Dutch government established educational objectives and a national curriculum. Those objectives for mathematics education are closely aligned with RME principles: in primary education, students should be able to understand and resolve both practical and theoretical mathematical problems (Van den Heuvel-Panhuizen and Wijers, 2005) in secondary education they should not understand advanced theories and practical problems but also develop functional mathematics skills, such as group problem-solving, mathematical communication, and critical thinking (Van den Heuvel-Panhuizen and Wijers, 2005).

Although the US education system is decentralized, the National Council of Teachers of Mathematics' (NCTM) teaching goals refer to the importance of teaching methods that first identifies students' existing knowledge to provide appropriate support. In addition, NCTM's learning goals emphasizes students' active participation in building and understanding concepts (National Council of Teachers of Mathematics, 2014).

Unlike their developed counterparts, Indonesia took a bottom-up approach to integratng RME into its education system. Despite several attempts to reform mathematics education by the Indonesian government, the general opinion was that its impact remained uncertain (Sembiring *et al.*, 2008). Consequently, several Dutch mathematics teachers supported a group of four Indonesian Ph.D. students to create an adapted version of RME—Pendidikan Mathematika Realistik Indonesia (PMRI)—(Sembiring *et al.*, 2010) which was rapidly adopted by Indonesia's education system over a short period. In fact, it was believed that RME would change the traditional, "spoon-feeding," method of teaching mathematics in Indonesia and enhance students' understanding of conceptual knowledge (Sembiring *et al.*, 2008).

3.2. Curriculum and Educational Materials

The curriculum and educational materials reflect not only the subject content but also the validity of learning objectives and outcomes (Drijvers *et al.*, 2019) therefore, a practical-based, flexible, and consistent curriculum indicates of a proper RME adaptation (Ponte *et al.*, 2009). However, this context-based approach requires an RME curriculum to be based on students' backgrounds and prior experiences (Revina and Leung, 2019) leading to RME differing drastically in each country's mathematics textbooks and curriculum.

At a very early stage, RME was extensively integrated into the US curriculum: a reality-based curriculum complemented by a series of RME-influenced textbooks—Mathematics in Context—had been established in Wisconsin during the 1990s (Van den Heuvel-Panhuizen and Drijvers, 2014). These efforts attracted growing attention nationally and internationally (for instance, see (Sembiring *et al.*, 2008; Yang *et al.*, 2010)). Van Den Heuvel-Panhuizen (2003) specifically examined RME teaching methods in helping students to understand percentages at three educational levels: at the first (grade 5) and second levels, students begin to learn about percentages and understand rational numbers and fractions. This incremental acquisition of knowledge is rooted in the level principle of RME, which requires students to reflect on a real problem and be able to formulate a general mathematics model (Remillard and Gardunia, 2015).

Unsurprisingly, integrating RME into the Dutch curriculum is widely discussed. When categorizing RME implementation styles, Julie and Mudaly (2007) indicated that the curriculum acts as either a vehicle or content, which are regarded as two ends of a spectrum. In the Netherlands, the RME curriculum tends toward the vehicle approach, which focuses on teaching mathematical concepts through contextual problems, although not centered on the learning certain mathematical concepts. Vos (2013) review, though, discovered that the replacement of technical terms and content, such as "word formula" for "alphabetic variables," and mathematical skills, such as data modeling, model interpretation, and everyday problem-solving, created both a context-rich environment and provided efficient theoretical knowledge. As the only developing Asian country, the Indonesian curriculum is very

different from the American and Dutch, particularly due to the students' different cultural background and experiences (Indonesia National Curriculum Centre, 2003). As a result, several studies (Clements and Sarama, 2004; Artigue, 2009) have indicated the need for specialized adaptations of RME to ensure implementation in a different culture is successful. The PMRI approach, using bottom-up implementation and consulting the Freudenthal Institute, has thus attracted the attention of various national and international stakeholders and engaged over 200 Indonesian schools in reforming mathematics teaching practice (Sembiring *et al.*, 2010).

3.3. Tests and Examinations

According to Crocker *et al.* (1989) the assessment procedure should reflect the curriculum: if the curriculum uses the realistic approach but assessments a traditional mechanical procedure, the student only learns to pass the test and neglects the learning path (English, 2000). Therefore, RME should be visible in not only the input (i.e., the curriculum) but also the output (i.e., assessment) process.

In the USA, several assessment authorities have demonstrated a degree of RME integration. The National Assessment of Educational Progress (NAEP) is explicit about tests measuring not only students' level of mathematical knowledge but also their ability to apply their understanding to real problem-solving (National Center for Education Statistics, 2019). Likewise, the College Board (2019) SAT mathematics examination measures students' ability to apply mathematics to problem-solving in real-life scenarios rather than mechanical mathematical knowledge, as their main objective is preparing students for college and future professions.

In the Netherlands, the national mathematics examination was adjusted in accordance with each major educational reform. Consequently, following RME implementation, in addition to closed questions, there were open-ended mathematical problems, closely related to real-life situations and illustrated by graphs or images, that required creative thinking and modeling ability. Several researchers have pointed out the similarities between the problems set in both the Dutch and Programme for International Student Assessment (PISA) tests (Vos, 2013) which would explain the Netherlands' high PISA ranking.

In Indonesia, assessment is mandatory for mathematics at all educational levels; however, the procedure measures mechanical mathematical knowledge. The 2018 national mathematics examination was the first based on higher-order thinking skills, which focuses on critical thinking and analyzing, comprehending, and applying mathematical knowledge (Watson, 2019). Unfortunately, students considered it to be the most difficult test in recent years (Swaragita, 2018) because, despite studying an RME curriculum, they were unfamiliar with RME assessment and probably required more time before being able to solve contextual problems presented as images or narratives (Retnawati *et al.*, 2017).

Non-government organizations have also attempted to develop alternative mathematics assessments based on a more practical approach: the tertiary education mathematics test and ACER mathematics assessment for incoming students from ACER Indonesia.

3.4. Teacher Training Program

Teachers play an important role in RME, providing guidance to enable students to achieve a higher level of mathematical understanding (Gravemeijer and Doorman, 1999). Where RME implementation has proved successful, the development of a proper teacher training program had been emphasized (Hadi *et al.*, 2010). Due to the focus on contextual problems, RME teachers must be flexible and realistic in their approach yet still prepared to direct their students toward a higher level of mathematical generalization and understanding. Without such guidance, RME would fail its ultimate objective of enabling students to comprehend advanced mathematical concepts (Gravemeijer *et al.*, 2016b). Thus, when reviewing the level of RME integration into an education system, it is essential to include the teacher training program in the analysis.

Supported by well-developed curriculum and educational materials, teachers in the USA are assured of a smooth implementation of RME. In fact, teachers' feedback was considered during the development of the curriculum to ensure consensus over the new teaching methods (Nicol and Crespo, 2006). US teachers rely heavily on textbooks for teaching (Macintyre and Hamilton, 2010), indicating successful implementation. Furthermore, the literature on American RME reveals an emphasis on the scientific approach to teachers' professional development (Lewis *et al*., 2009). However, despite several government attempts and millions of dollars in funding, the USA still suffers a shortage of teachers and adequate quality control over teaching training procedures to ensure the integration of RME into teaching practice (Ponte *et al*. (2009).

Although it is generally believed that Dutch teachers are more flexible, several studies (e.g., Gravemeijer *et al*. (2016a)) have pointed out that while mathematics teachers exercise more control over their lessons, they still depend on textbooks. Using a well-developed learning path, teachers can not only guide their students but also keep their learning progress on course. According to Vos (2013) before RME was formally implemented in the Netherlands, a curriculum, with illustrative examples, was piloted to allow teachers time to adapt to the new approach. An annual professional development workshop was also established nationwide (Hendriks *et al*., 2010) for mathematics teachers to become familiar with the RME approach. Moreover, teachers are required to regularly send a self-report on their implementation of RME to the authorities that monitor their performance (Vos, 2013).

Indonesia was one of the earliest Asian developing countries to implement RME. Recent studies show how the importance of teacher training, due to the guidance principle of RME, has been recognized (Revina and Leung, 2019). However, the main factor behind the variation between Indonesian and Dutch teaching practices is their cultural differences, especially in terms of the teacher's role (Revina and Leung, 2019). Consequently, Indonesian students are often taught in a conventional passive style, in which they do not express disagreement or interact with their classmates, in contrast to the flexible and individualist approach in the Netherlands (Revina and Leung, 2019). Due to this traditional teaching role, one core principle is overlooked in the Indonesian RME curriculum: activity, or a learning path that allows students' active participation in acquiring knowledge (Dolk, 2010; Revina and Leung, 2019). Without proper teacher training, RME will be taught in an inflexible and didactic style, which defeats the purpose of active participation (Freudenthal, 1973) however, there is little evidence from the literature that an RME-oriented teacher training program exists in Indonesia.

4. AN OVERVIEW OF THE EDUCATION SYSTEM AND MATHEMATICS EDUCATION IN VIETNAM

With over 16 million children of school age (UNESCO Institute for Statistics, 2017), providing universal access to primary and secondary education is one of the Vietnamese government's main aims (Vietnam Central Steering Committee, 2013). Its efforts in the structural reform of the education system has been evident in recent years (for instance, see Vietnam Ministry of Education and Training (2017)) alongside the involvement of both private and civil stakeholders in several educational projects, such as the high-profile Viet Nam Escuela Nueva (VNEN) project—a student-centered, independent-learning model for primary and secondary education (World Bank, 2012). Overall, educational reform in Vietnam is moving toward practical-based instruction to help students to adapt in a fast-changing society (VMET, 2017), but some practices and policies are criticized as poor imitations of those in other countries (Nguyen, 2016). Under pressure from national and international stakeholders, the government and private sector in Vietnam are working toward a universally accessible and practical-based education system that can be flexible and suitable for the Vietnamese context.

As a preeminent subject, mathematics is of great interest to both academics and laypeople and has become central to the discussion on the state of Vietnamese education. Vietnamese students regularly achieve high scores in international mathematics competitions and assessments (e.g., PISA, the International Mathematical Olympiad for high school students), while Vietnam's volume of mathematics research output has resulted in recognition for its

academic performance. Indeed, Vietnam ranked 53rd in 2018 among countries with international publications indexed by the Scopus database (Scimago, 2018) as well as producing more eminent academics in the mathematics field than other developing countries, such as Prof. Ngo Bao Chau (awarded the Fields Medal in 2010) and Prof. Hoang Tuy (inventor of Tuy's cut; see Tuy (2001)).

The Vietnamese government consistently prioritizes mathematics and puts it at the center of the education system: along with literature and foreign languages, mathematics is a mandatory subject in the National High School Graduation Examinations. Therefore, being considered core subject by not only teachers and students but also parents, mathematics is open to extensive criticism. While public opinion regards the mathematics curriculum as ponderous and theoretical (for instance, see Quynh (2014)) several mathematicians and experts argue that the real problem was the teaching methods rather than the subject content (Linh, 2018). Some recent studies (for example, see (Nguyen, 2018; Nguyen *et al.*, 2019)) have indeed reported that a large number of students experience difficulties in learning mathematics. Given this situation, both policymakers and private stakeholders have persevered with the reforms and produced the new mathematics curriculum (VMET, 2018) as well as several institutional and individual initiatives. Although RME appears to be an appropriate and promising solution, national researchers have not yet paid it much attention. However, by examining educational policies and teaching practices for elements of RME, this study aims to identify the current position of the realistic approach in the Vietnamese education system.

5. THE INTRODUCTION OF RME INTO THE VIETNAMESE EDUCATION SYSTEM

Ten years after two Ph.D. students, Nguyen (2005) and Le (2006) took the initiative and independently introduced RME to Vietnamese education by means of their overseas Ph.D. dissertations, little implementation had been undertaken. However, between 2005 and 2015 there was an increased emphasis on practical-based teaching methods for mathematics, followed by official recognition in 2016 with the new qualification framework (Vietnam Prime Minister of Government, 2016). Since then, both national and international private organizations have also attempted to integrate RME into the Vietnamese curriculum, testing procedures, and teacher training programs. This section analyzes the current situation using the framework described in Section 3.

5.1. National Strategy and Vision

In 2005, the term *thực tiễn* (realistic) was first used officially in discussions on the education law (VNA, 2005) followed by its inclusion in Decision 16/2006/QĐ-BGDĐT announcing the general education program (VMET, 2006). However, the objectives of primary and secondary mathematics education still failed to reflect RME, focusing on students' acquisition of basic mathematical skills.

Despite several adjustments to the education system over the next five years, traditional teaching methods persisted in mathematics education, prompting considerable criticism of a poorly developed curriculum and ineffective teaching methods (Giang, 2008).

By 2013, the education system was acknowledged as too theoretical and detached from real life and Resolution 29 aimed at radical reform Vietnam Central Party Executive Committee (2013). In line with the 2005 education law, Resolution 29 emphasized the need for education to enable students to apply their knowledge to real-life situations. However, RME is yet to be mentioned in any national vision or long-term educational strategy.

In 2010, Prof. Ngo Bao Chau (at the University of Chicago) became the first Vietnamese to be awarded the most prestigious prize in mathematics, the Fields Medal (Minh, 2010), attracted the public's attention to mathematics. As a result, the Vietnamese government approved the special 10-year National Program for the Development of Mathematics (NPDM) (2010-2020) in terms of both research and teaching (VPMG, 2010). Unfortunately, ambitious plan overlooked RME and focused mainly on research and gifted training in mathematics.

The Decision on Approving Vietnam's National Qualification Framework (VPMG, 2010) enabled the education system to effectively categorize and standardize different aspects of the education system. As the integration of RME depends on the support of various educational stakeholders, constitutionalizing a standard framework could create the political basis to bring about RME implementation in Vietnam. In fact, the new mathematics curriculum (VMET, 2018) discussed in Section 5.2, is a significant step toward top-down implementation of RME in Vietnam.

In conclusion, from 2005 to 2019, both a practical-based approach to education in general and RME in particular have been mentioned in Vietnamese policies and strategies to different degrees. However, it appears that no detailed official implementation plan for exists at a national level in Vietnam as yet.

5.2. Curriculum and Educational Materials

On the one hand, including a specific teaching method in the national vision and strategy requires extensive consideration; on the other hand, due to constant re-evaluation of the national education strategy, those developing the curriculum and educational materials have more opportunity to experiment with different approaches.

Even before RME was introduced in Vietnam, the term "realistic mathematics" had first appeared in a 2003 official document, but only in reference to a non-formal education program for adults (VMET, 2003). Real-life mathematical problems remained a minor part of the curriculum until 2006 (VMET, 2006) when they were introduced for students to not only practice and memorize new knowledge but also enhance their inductive reasoning, which connected mathematical knowledge with other factors of RME.

Despite certain RME-like attributes, the 2006 curriculum was still criticized for being theoretical and ineffective. Specifically, academics argued that its content and objectives were being deliberately distorted to achieve higher scores in important tests and examinations (for instance, see Duong (2019)).

While the new mathematics curriculum takes a similar realistic approach to its 2006 predecessor, it also includes a specific learning path for students to achieve their own objectives (VMET, 2018). Specifically, the 2018 curriculum moves nearer to RME by focusing more on teamwork and scientific communication skills, encouraging students' active participation in learning, and improving their inductive reasoning of mathematical concepts from solving real-life problems (VMET, 2018). Furthermore, it guarantees that 7% of mathematics lessons will be spent on practical activities and experimental scenarios (VMET, 2018).

Since 2010, mathematics education has attracted more attention from not only the government but also the private sector. Despite remaining highly critical of recent policies, well-informed Vietnamese parents acknowledge the importance of mathematics, resulting in selective schools, especially private schools, adopting new teaching approaches and initiatives. One example is the "Learn Math with Jenny" program (see hoctoancungjenny.edu.vn), based on a Vietnamese doctorate in mathematics from Harvard, that aims to encourage students to learn math actively and creatively; another is the "Improving Mathematical Thinking with a Personal-Oriented Program for Children" (POMATH; see pomath.vn) that intends to help individual students overcome common problems in learning by using their imagination to solve fun real-life problems.

Several publishers of educational materials are responding to the recent shift toward the realistic approach in the mathematics curriculum and assessments, while teachers are now realizing that this approach helps students to not only improve their understanding but also negotiate practical problems in examinations (Pham and Nguyen, 2016). With an upsurge in demand, this period witnessed an unprecedented number of realistic mathematics reference books being published (Nguyen, 2017; Vu *et al.*, 2017; Nguyen and Tang, 2018). Moreover, the "Learn Math with Jenny" program has developed a mathematics book series (HoctoancungJenny, 2017) based on popular Vietnamese fairy tales, which are not only closely related to Vietnamese children's background but also the realistic approach of RME.

5.3. Tests and Examinations

The Vietnamese education system places great emphasis on tests and examinations (Bui, 2018) leading to students learning for the test rather than gaining the understanding to achieve the educational objectives (Ha, 2018). Thus, without a corresponding assessment procedure, the application of RME in the curriculum is restricted. Although little was undertaken in terms of integrating RME into assessments during the period of 2005–2010, since then an increasing number of real-life problems have been introduced into different levels of examination and it is proposed to develop a realistic assessment system for mathematics.

Consequently, there was a brief reference in the 2006 mathematics curriculum to a combination of assessment methods that include research activities and experiments inside and outside the classroom. This was followed by the government's acknowledgment in Resolution 29 (VCSC, 2013) of the senseless pursuit of qualifications and scores and its commitment to improving the assessment system.

A momentous phase commenced from that time onwards with the Vietnamese Ministry of Education and Training trying out various assessment methods, despite growing pressure from Vietnamese students and teachers needing time to adapt to the changes (Dung, 2018). For the first time in 2016, RME was incorporated into the new mathematics National High School Graduation Examination, which includes highly practical questions related to monetary and everyday problems (VPMG, 2016; Phuong, 2017). According to several teachers (Nguyen, 2016; Nguyen, 2018; Nguyen *et al.*, 2019) these real-life problems require an extensive understanding of mathematics, but many students are not familiar with this type of question, illustrating a discrepancy between the curriculum, as well as teaching methods, and the assessment procedure. As a result, the minimum entrance score required has dropped across Vietnam (Hoang, 2019). Another method under consideration is summative assessment: the new 2018 mathematics curriculum (VMET, 2018) specifies that students should be tested on their inductive reasoning, critical thinking, scientific communication, and real-li mathematical problem-solving. Overall, despite a slow start, formal mathematics assessment will be increasingly directed toward the RME approach in future.

5.4. Teacher Training Program

Apart from the interrelationship between the curriculum and assessment procedure, as well as government support, another key factor in the complete integration of RME is human. According to the guidance principle of RME, the teacher plays a significant role in the student learning process (Van den Heuvel-Panhuizen and Wijers, 2005); however, as discussed earlier, the human factor has been a major obstacle to RME implementation (e.g., Indonesia, the USA). A proper teacher training program providing sufficient background for teachers to fulfill their guidance role is therefore crucial for successful implementation. This is particularly difficult in Vietnam where the roles of teacher and student are fixed (Lewis, 2002).

Thus, complementary educational materials were introduced under the 2006 mathematics curriculum to support teachers with developing students' mathematical knowledge through different engaging situations and teamwork (VMET, 2006). As in the Netherlands, Vietnamese mathematics textbooks provide a learning path for both teachers and students; however, due to the lack of realistic mathematics content and emphasis on achieving higher examination results, despite encouraging student's active participation, the textbooks proved rather inadequate. The government also plays a role in improving teachers' capabilities, though: the Decision on the regular training cycle for mathematics teachers between 2004 and 2007 (VMET, 2004) included 11 out of a total of 115 sessions (13%) devoted to RME-related teaching methods, such as applying mathematics in real life, using inductive reasoning, and learning through group activities. Despite the small number of sessions, this was the ministry's initial attempt to improve mathematics teaching methods by including real-life problem-solving and active participation. However, both the professionals and public regarded such training programs as ineffectual (Dantri, 2016). Therefore, Resolution 29 (VCSC, 2013) concluded that enhancing human resources in the education sector and encouraging staff to be innovative in their teaching and educational approaches were essential to further

progress. Due to the growing popularity of RME, improving teachers' capabilities has been divided between the previously dominant top-down policies and bottom-up initiatives. For instance, Nguyen (2017) has highlighted several problems with current teaching methods and provided suggestions for teacher initiatives, such as including real-life problems to which students can relate, developing clear learning path for each lesson, and encouraging group discussions. In attempting to reform mathematics education in Vietnam, Prof. Do Duc Thai stated that teachers must understand the latent philosophy underpinning the curriculum for it to be successful (VMET, 2018). Thus, the process of enhancing teachers' capabilities is expected to be a slow and gradual process, ensuring a change in teachers' mindsets and a thorough understanding of the curriculum. The vision for the new mathematics curriculum is that in future, teachers will have complete independence, or as Prof. Do Duc Thai commented: "Ideally, we will no longer need textbooks because each teacher will themselves be the book" (Thuy, 2019b).

6. CONCLUSION

The application of RME in Vietnam was rare from its introduction in 2005 to 2010; however, following Resolution 29 in 2013, RME received extensive attention from not only the government but also the public, private sector, and teachers. In addition, the ongoing development of the new curriculum in general and its focus on realistic mathematics in particular promises major adjustment in Vietnamese mathematics education.

Overall, the RME implementation from 2010 to 2019 has been more extensive than between 2000 and 2010. Moving forward, Vietnam takes the benefit from years of experience in adapting a realistic approach and a strong foundation laid by the government and other stakeholders, such as private schools and parents. However, as in Indonesia and the USA, Vietnam lacks the human resources to effectively implement RME: both teaching training programs and the process of adapting the RME curriculum to the Vietnamese context requires considerable time and money to succeed. Nevertheless, despite the delayed and slow implementation, RME has still made advancements into the Vietnamese education system.

Over the last 30 years, RME has proved an effective approach to mathematics teaching worldwide. In the current era of science and technology, the importance of mathematics in general and RME in particular has also significantly increased. Having a young population and a large number of school-age children, Vietnam's new objective in developing mathematics is open to RME in terms of practice and research. As such, this study aims to contribute the basis for further study of RME in Vietnam. Future studies should undertake more empirical research, focusing on the crucial problems of implementing RME in Vietnam, such as adjustments to the assessment procedure to properly measure RME learning outcomes (for example, see Drijvers *et al.* (2019)) and support for teachers to fully incorporate RME into their practice (for example, see Sevinc and Lesh (2017)).

Funding: This research was sponsored by NAFOSTED, Vietnam (Grant No: 503.01–2019.301).
Competing Interests: The authors declare that they have no competing interests.
Acknowledgement: The authors also wish to thank Thai Quoc Cao of the Center for Research and Practice in Education at Phu Xuan University for his excellent assistance.

REFERENCES

Artigue, M., 2009. Didactical design in mathematics education. In Nordic research in mathematics education. Brill Sense. pp: 5-16.

Bui, N., 2018. Does Vietnamese education teach students just to take exams, does not help life? (Does the Vietnam education system prepare students just for test, not for life?). GiaoducVietnam. Available from https://giaoduc.net.vn/giao-duc-24h/co-phai-giao-duc-viet-nam-day-hoc-sinh-chi-de-thi-khong-giup-gi-cho-cuoc-song-post192004.gd.

Chen, L., W. van Dooren, Q. Chen and L. Verschaffel, 2011. An investigation on chinese teachers' realistic problem posing and problem solving ability and beliefs. International journal of science and mathematics education. 9(4): 919–948.Available at: https://doi.org/10.1007/s10763-010-9259-7.

Clements, D.H. and J. Sarama, 2004. Learning trajectories in Mathematics education. Mathematical Thinking and Learning, 6(2): 81–89.Available at: https://doi.org/10.1207/s15327833mtl0602_1.

College Board, 2019. College board. Available from https://www.collegeboard.org/.

Crocker, L.M., M.D. Miller and E.A. Franks, 1989. Quantitative methods for assessing the fit between test and curriculum. Applied Measurement in Education, 2(2): 179-194.Available at: https://doi.org/10.1207/s15324818ame0202_6

Dantri, 2016. Obsolete traditional teacher training model? (is the model of traditional teacher training obsolete?). Dantri. Available from https://dantri.com.vn/viec-lam/mo-hinh-dao-tao-giao-vien-truyen-thong-da-loi-thoi-20160521221514657.htm.

Dolk, M., 2010. Examining teachers' role in relation to their beliefs and expectations about students' thinking in design research. In R. Sembiring, K. Hoogland, & M. Dolk (Eds.), A Decade of PMRI in Indonesia. Meppel: Bandung: Utrecht. pp: 175–188.

Drijvers, P., H. Kodde-Buitenhuis and M. Doorman, 2019. Assessing mathematical thinking as part of curriculum reform in the Netherlands. Educational Studies in Mathematics, 102(3): 435-456.Available at: https://doi.org/10.1007/s10649-019-09905-7.

Dung, H., 2018. Dizziness because the exam structure is constantly changing (Dizzy from the continuous changing structure of examination). VOV Vietnam. Available from https://vov.vn/xa-hoi/giao-duc/chong-mat-vi-cau-truc-de-thi-lien-tuc-thay-doi-726354.vov.

Duong, T., 2019. Two major innovations in teaching Math under the new curriculum. Tienphong. Available from https://vnexpress.net/giao-duc/hai-doi-moi-chinh-trong-day-toan-theo-chuong-trinh-moi-3920681.html.

English, F., 2000. Deciding what to teach and test: Developing, aligning, and auditing the curriculum. California: Corwin Press.

Freudenthal, H., 1973. Mathematics as an educational task. Dordrecht: Reidel Publishing.

Giang, H.T., 2008. Heavy theory, lack of reality. Lao Dong. Available from https://nld.com.vn/giao-duc-khoa-hoc/nang-ly-thuyet--thieu-thuc-te-246187.htm.

Gravemeijer, K., G. Bruin-Muurling, J.M. Kraemer and I. van Stiphout, 2016a. Shortcomings of Mathematics education reform in the Netherlands: A paradigm case? Mathematical Thinking and Learning, 18(1): 25–44.Available at: https://doi.org/10.1080/10986065.2016.1107821.

Gravemeijer, K., G. Bruin-Muurling, J.M. Kraemer and I. van Stiphout, 2016b. Shortcomings of Mathematics education reform in the Netherlands: A paradigm case? Mathematical Thinking and Learning, 18(1): 25–44.Available at: https://doi.org/10.1080/10986065.2016.1107821.

Gravemeijer, K. and M. Doorman, 1999. Context problems in realistic mathematics education: A calculus course as an example. Educational Studies in Mathematics, 39(1-3): 111-129.

Ha, L., 2018. Education examinations seriously, how to neutralize? (how to reduce the heavy emphasis on testing score in the education system?). Baomoi. Available from https://baomoi.com/giao-duc-nang-thi-cu-lam-sao-hoa-giai/c/26379924.epi.

Hadi, S., M. Dolk, Meiliasari and P. Sari, 2010. The role of key teachers in PMRI dissemination. In R. Sembiring, K. Hoogland, & M. Dolk (Eds.), A decade of PMRI in Indonesia. Meppel: Bandung, Utrecht. pp: 123–130.

Hendriks, M.A., H. Luyten, J. Scheerens, P. Sleegers and R. Steen, 2010. Teachers' professional development Europe in international comparison: An analysis of teachers' professional development based on the OECD's Teaching and Learning International Survey (TALIS). In J. Scheerens (Ed.), Office for Official Publications of the European Union. Available from https://doi.org/10.2766/63494.

Hoang, H., 2019. Benchmark grade 10 HCMC this year due to where? (Why does HCMC's grade 10 benchmark score this year decrease?). Tuoitre. Available from https://tuoitre.vn/diem-chuan-lop-10-tp-hcm-nam-nay-giam-do-dau-20190703094742701.htm.

HoctoancungJenny, 2017. Learn Math with Jenny. Retrieved from HoctoancungJenny. Available from http://hoctoancungjenny.edu.vn/tap-san/.

Indonesia National Curriculum Centre, 2003. The curriculum 2004: The competence standards for mathematics in Junior High School and Islamic Junior High School. Jakarta, Indonesia: Departemen Pendidikan Nasional. Available from https://www.academia.edu/34964654/K_U_R_I_K_U_L_U_M_2_0_0_4_STANDAR_KOMPETENSI.

Julie, C. and V. Mudaly, 2007. Mathematical modelling of social issues in school mathematics in South Africa. In Modelling and applications in mathematics education. Boston, MA: Springer. pp: 503-510.

Le, T.A., 2006. Applying realistic mathematics education in Vietnam: Teaching middle school geometry (Universität Potsdam). Available from https://publishup.uni-potsdam.de/opus4-ubp/files/1232/le_diss.pdf.

Lestari, L. and E. Surya, 2017. The effectiveness of realistic mathematics education approach on ability of students' mathematical concept understanding. International Journal of Sciences: Basic and Applied Research, 34(1): 91-100.

Lewis, C.C., R.R. Perry and J. Hurd, 2009. Improving mathematics instruction through lesson study: A theoretical model and North American case. Journal of Mathematics Teacher Education, 12(4): 285-304.Available at: https://doi.org/10.1007/s10857-009-9102-7.

Lewis, M., 2002. Cultures of teaching: Voices from Vietnam. ELT Journal, 56(2): 146–153.Available at: https://doi.org/10.1093/elt/56.2.146.

Linh, N., 2018. GS. Ngo Bao Chau: Many children learn Math like a "machine" (Prof. Ngo Bao Chau: Many children learn Math like 'a machine'). Baomoi. Available from https://baomoi.com/gs-ngo-bao-chau-nhieu-em-hoc-toan-nhu-cai-may/c/27328119.epi.

Macintyre, T. and S. Hamilton, 2010. Mathematics learners and Mathematics textbooks: A question of identity? Whose curriculum? Whose Mathematics? The Curriculum Journal, 21(1): 3-23.Available at: https://doi.org/10.1080/09585170903558224.

Makonye, J.P., 2017. Teaching functions using a realistic Mathematics education approach: A theoretical perspective. International Journal of Educational Sciences, 7(3): 653–662.Available at: https://doi.org/10.1080/09751122.2014.11890228.

Minh, L., 2010. Professor Ngo Bao Chau won the fields Math prize (Professor Ngo Bao Chau won the Fields Mathematics prize). Vnexpress. Available from https://vnexpress.net/khoa-hoc/giao-su-ngo-bao-chau-doat-giai-toan-hoc-fields-2173209.html.

National Center for Education Statistics, 2019. Mathematics. Available from https://nces.ed.gov/nationsreportcard/mathematics/.

National Council of Teachers of Mathematics, 2014. Executive summary: Principles and standards for school Mathematics. National Council of Teachers of Mathematics. pp: 1–6.

Nguyen, B.H., 2017. Improve and develop solutions to solve realistic mathematics problems. Available from https://tiki.vn/nang-cao-va-phat-trien-ky-nang-giai-bai-toan-thuc-te-mon-toan-p1387589.html?spid=1389567&utm_source=google&utm_medium=cpc&utm_campaign=SEA_NBR_GGL_PLA_DTP_ALL_VN_ALL_UNK_UNK_C.ALL_X.1057274772_Y.54169762056_V.1389567_W.DT_A.636116538219&gc.

Nguyen, D., 2016. The appearance of realistic Mathematics problems in the illustrative exam questions appears. Available from https://kenhtuyensinh.com.vn/de-thi-minh-hoa-xuat-hien-bai-toan-lien-he-thuc-te.

Nguyen, D.N., 2016. Modeling method in mathematics teaching in school. Thai Nguyen, Vietnam: Thai Nguyen University Publishing House. Retrieved from http://nxb.tnu.edu.vn/Sach/details/452.

Nguyen, Q.T., 2017. Mr. Quang Thi and the teaching of Mathematics through practical problems (Mr. Quang Thi and the teaching of Mathematics through practical problems). GiaoducVietnam. Available from https://giaoduc.net.vn/giao-duc-24h/thay-quang-thi-va-viec-giang-day-toan-hoc-thong-qua-cac-bai-toan-thuc-te-post182324.gd.

Nguyen, T., 2005. Learning to teach realistic mathematics in Vietnam. PhD Thesis, University of Amsterdam. Available from https://dare.uva.nl/search?identifier=fadc5f29-40f2-4ce6-a1c1-48678a3451bb.

Nguyen, T.T., 2018. Some suggestions on the application of the realistic Mathematics education and the didactical situations in mathematics teaching in Vietnam. HNUE Journal of Science, 63(9): 24-33.

Nguyen, T.T., T.P.T. Trinh and T. Tran, 2019. Realistic Mathematics education (RME) and didatical situations in Mathematics (DSM) in the context of education reform in Vietnam. Journal of Physics: Conference Series, 1340: 012032.

Nguyen, T.T.T., 2018. Teaching in the direction of supporting grade 4 students having difficulty in learning Math (Mathematics instruction for grade 4 students with learning increasingly). Doctor of Education Thesis, Hanoi Pedagogical University, 2. Available from http://hpu2.edu.vn/uploads/news/2017_12/toan-van-luan-an.pdf.

Nguyen, V.V. and M.D. Tang, 2018. Collection of realistic mathematics problems. Ho Chi Minh, Vietnam: Dai hoc su pham Tp Ho Chi Minh.

Nicol, C.C. and S.M. Crespo, 2006. Learning to teach with Mathematics textbooks: How preservice teachers interpret and use curriculum materials. Educational Studies in Mathematics, 62(3): 331-355.Available at: https://doi.org/10.1007/s10649-006-5423-y.

Niss, M.A., 1996. Goals of Mathematics teaching. In International Handbook of Mathematics Education. pp: 49–97. Available from https://doi.org/10.1007/978-94-009-1465-0_3.

Pham, N.Q. and T.H. Nguyen, 2016. Building a system of practical exercises in teaching mathematics (develop a system of practical exercises in teaching mathematics). GiaoducvaThoidai. Available from https://giaoducthoidai.vn/trao-doi/xay-dung-he-thong-bai-tap-thuc-tien-trong-giang-day-toan-hoc-2244558.html.

Phuong, L., 2017. The structure of the illustration for Mathematics for entrance exam 10 years in 2018 in Saigon (The pilot structure of grade 10 entrance examination in Sai Gon). GiaoducVietnam. Available from https://giaoduc.net.vn/GDVN/Cau-truc-de-minh-hoa-Toan-tuyen-sinh-10-nam-2018-o-Sai-Gon-post179665.gd.

Ponte, J.P.D., O. Zaslavsky, E. Silver, M.D.C. Borba, M.V.D. Heuvel-Panhuizen, H. Gal, D. Fiorentini, R. Miskulin, C. Passos and G.D.L.R. Palis, 2009. Tools and settings supporting mathematics teachers' learning in and from practice. In R. Even & D. L. Ball (Eds.), The Professional Education and Development of Teachers of Mathematics. pp: 185–209. Available from https://doi.org/10.1007/978-0-387-09601-8_20.

Quynh, T., 2014. Vietnamese students in grade 4 doing maths in grade 7 of the UK (Vietnamese students in grade 4 have to solve mathematics problems of UK students in context mentioned above 7). Vnexpress. Available from https://vnexpress.net/giao-duc/hoc-sinh-viet-nam-lop-4-lam-toan-lop-7-cua-anh-3096949.html.

Remillard, J. and B. Gardunia, 2015. Mathematics curriculum, teacher professionalism, and supporting policies in Korea and the United States. In Mathematics Curriculum, Teacher Professionalism, and Supporting Policies in Korea and the United States: Summary of a Workshop. Available from https://doi.org/10.17226/21753.

Retnawati, H., B. Kartowagiran, J. Arlinwibowo and E. Sulistyaningsih, 2017. Why are the Mathematics national examination items difficult and what is teachers' strategy to overcome it? International Journal of Instruction, 10(3): 257-276.Available at: https://doi.org/10.12973/iji.2017.10317a.

Revina, S. and F.K.S. Leung, 2019. How the same flowers grow in different soils? The implementation of realistic Mathematics education in Utrecht and Jakarta classrooms. International Journal of Science and Mathematics Education, 17(3): 565-589.Available at: https://doi.org/10.1007/s10763-018-9883-1.

Scimago, 2018. Countries ranking of Mathematics documents from 1996 to 2018. Available from https://www.scimagojr.com/countryrank.php?area=2600.

Sembiring, R., S. Hadi and M. Dolk, 2008. Reforming mathematics learning in Indonesian classrooms through RME. ZDM - International Journal on Mathematics Education, 40(6): 927–939.Available at: https://doi.org/10.1007/s11858-008-0125-9.

Sembiring, R., K. Hoogland and M. Dolk, 2010. A decade of PMRI in Indonesia (R. Sembiring, K. Hoogland, & M. Dolk, Eds.). Bandung, Utrecht: Ten Brink, Meppel.

Sevinc, S. and R. Lesh, 2017. Training mathematics teachers for realistic math problems: A case of modeling-based teacher education courses. ZDM - Mathematics Education, 50(1–2): 301–314.Available at: https://doi.org/10.1007/s11858-017-0898-9.

Swaragita, G., 2018. Indonesian exams "too hard", students "want to die. Available from https://www.thejakartapost.com/news/2018/04/14/indonesian-exams-too-hard-students-want-to-die.html.

Thuy, N., 2019a. Keeping on the first level of enrollment like this, the new Math program will "die from the egg" (Keep on testing Mathematics like the recent examination, the new Mathematics program will 'die prematurely'). Vietnamnet. Available from https://vietnamnet.vn/vn/giao-duc/nguoi-thay/tuyen-sinh-nhu-vua-qua-chuong-trinh-giao-duc-pho-thong-moi-chet-tu-trong-trung-540080.html.

Thuy, N., 2019b. Keeping on the first level of enrollment like this, the new Math program will "die from the egg" (Keep on testing Mathematics like the recent examination, the new Mathematics program will 'die prematurely'). Vietnamnet. Available from https://vietnamnet.vn/vn/giao-duc/nguoi-thay/tuyen-sinh-nhu-vua-qua-chuong-trinh-giao-duc-pho-thong-moi-chet-tu-trong-trung-540080.html.

Treffers, A., 1987. Three dimensions. The Reidel Publishing Company. Available from https://doi.org/10.1007/978-94-009-3707-9.

Tuy, H., 2001. Cutting plane methods for global optimization. In Encyclopedia of Optimization. pp: 590–594. Available from https://doi.org/10.1007/978-0-387-74759-0_104.

UNESCO Institute for Statistics, 2017. Vietnam. Available from http://uis.unesco.org/country/VN.

United Nations, 2015. UN general assembly's open working group proposes sustainable development goals. Available from http://sustainabledevelopment.un.org/content/documents/4538pressowg13.pdf.

Van den Heuvel-Panhuizen, M., 2000. Mathematics education in the Netherlands: A guided tour. Freudenthal Institute Cd-Rom for ICME9. Utrecht: Utrecht University, 2(March 1999): 26–27.

Van Den Heuvel-Panhuizen, M., 2003. The didactical use of models in realistic Mathematics education: An example from a longitudinal trajectory on percentage. Educational Studies in Mathematics, 54(1): 9-35.Available at: https://doi.org/10.1023/b:educ.0000005212.03219.dc.

Van den Heuvel-Panhuizen, M. and P. Drijvers, 2014. Encyclopedia of mathematics education. In S. Lerman (Ed.), Encyclopedia of Mathematics Education. Springer Science+Business Media Dordrecht. Available from https://doi.org/10.1007/978-94-007-4978-8.

Van den Heuvel-Panhuizen, M. and M. Wijers, 2005. Mathematics standards and curricula in the Netherlands. ZDM, 37(4): 287-307.Available at: https://doi.org/10.1007/bf02655816.

Vietnam Central Party Executive Committee, 2013. Resolution No. 29-NQ/TW on radical and comprehensive renovation of education and training to meet requirements of modernization and industrialization in the socialist-oriented market economy and international integration. Available from https://moet.gov.vn/tintuc/Pages/doi-moi-can-ban-toan-dien-gd-va-dt.aspx?ItemID=3928.

Vietnam Central Steering Committee, 2013. Resolution on basic and comprehensive renovation of education and training, meeting the requirements of industrialization and modernization in the conditions of socialist-oriented market economy and international integration. Available from https://thuvienphapluat.vn/van-ban/Thuong-mai/Nghi-quyet-29-NQ-TW-nam-2013-doi-moi-can-ban-toan-dien-giao-duc-dao-tao-hoi-nhap-quoc-te-212441.aspx.

Vietnam Ministry of Education and Training, 2017. Plan of implementing goals for sustainable development in the field of education and training. Available from https://thuvienphapluat.vn/van-ban/Giao-duc/Quyet-dinh-2161-QD-BGDDT-2017-Ke-hoach-phat-trien-ben-vung-giao-duc-dao-tao-2025-2030-353688.aspx.

Vietnam National Assembly, 2014. Resolution No. 88/2014/QH13 on renewing general education textbooks and curriculum. Available from http://chuongtrinhkhgd.moet.gov.vn/van-ban/Pages/chi-tiet-van-ban.aspx?ItemID=1252.

Vietnam Prime Minister of Government, 2016. Decision 1982/QĐ-TTg on approving Vietnam's national qualification framework. Available from https://thuvienphapluat.vn/van-ban/giao-duc/Quyet-dinh-1982-QD-TTg-phe-duyet-khung-trinh-do-quoc-gia-Viet-Nam-2016-327841.aspx.

VMET, 2003. Decision on the issuance of the primary education supplement program. Available from https://thuvienphapluat.vn/van-ban/Giao-duc/Quyet-dinh-46-2003-QD-BGDDT-Chuong-trinh-Giao-duc-bo-tuc-tieu-hoc-17463.aspx.

VMET, 2004. Decision on the issuance of a regular periodic training program (2004-2007) for middle school teachers. Available from https://thuvienphapluat.vn/van-ban/Giao-duc/Quyet-dinh-14-2004-QD-BGDDT-Khung-chuong-trinh-boi-duong-thuong-xuyen-chu-ky-III-2004-2007-giao-vien-Trung-hoc-co-so-17461.aspx.

VMET, 2006. Decision 16/2006/QD-BGDDT dated May 5, 2006 Promulgating general education program. Available from https://thuvienphapluat.vn/van-ban/Giao-duc/Quyet-dinh-16-2006-QD-BGDDT-chuong-trinh-giao-duc-pho-thong-55984.aspx.

VMET, 2017. Plan of implementing goals for sustainable development in the field of education and training.

VMET, 2018. Mathematics education program for secondary education. Available from https://data.moet.gov.vn/index.php/s/m6ztfi7sUIIGQdY#pdfviewer.

VNA, 2005. Education law of the national assembly of the socialist Republic of Vietnam No. 38/2005 / QH11 dated June 14 , 2005). Available from http://congbao.chinhphu.vn/tai-ve-van-ban-so-23-vbhn-vpqh-1249-398?format=pdf.

Vos, P., 2013. The Dutch maths curriculum: 25 Years of modelling. In R. Lesh et al. (eds.), Modeling Students' Mathematical Modeling Competencies, International Perspectives on the Teaching and Learning of Mathematical Modelling Springer Science+Business Media Dordrecht. pp: 611–620. Available from https://doi.org/10.1007/978-94-007-6271-8_53.

VPMG, 2010. Decision approving the national key program on mathematical development in the 2010-2010 period. Available from http://www.chinhphu.vn/portal/page/portal/chinhphu/noidungchuongtrinhquocgiakhac?_piref135_18254_135_18253_18253.strutsAction=ViewDetailAction.do&_piref135_18254_135_18253_18253.docid=1118&_piref135_18254_135_18253_18253.substract=&fbclid=IwAR0F7rAD3kw8ya.

VPMG, 2016. Decision on approving Vietnam's national qualification framework. Available from https://thuvienphapluat.vn/van-ban/Giao-duc/Quyet-dinh-1982-QD-TTg-phe-duyet-khung-trinh-do-quoc-gia-Viet-Nam-2016-327841.aspx.

Vu, T.D., N.T. Phung and N.S. Le, 2017. Mathematics and life: interesting stories. Hanoi, Vietnam: Vietnam Education Publishing House.

Watson, S., 2019. Higher-order thinking skills (HOTS) in education. Available from https://www.thoughtco.com/higher-order-thinking-skills-hots-education-3111297.

World Bank, 2012. Vietnam Escuela Nueva: A new and exciting way of learning. Available from https://www.worldbank.org/en/news/feature/2012/10/10/vietnam-escuela-nueva-a-new-and-exciting-way-of-learning.

Yang, D.-C., R.E. Reys and L.-L. Wu, 2010. Comparing the development of fractions in the Fifth-and Sixth-graders' textbooks of Singapore, Taiwan, and the USA. School Science and Mathematics, 110(3): 118-127.Available at: https://doi.org/10.1111/j.1949-8594.2010.00015.x.