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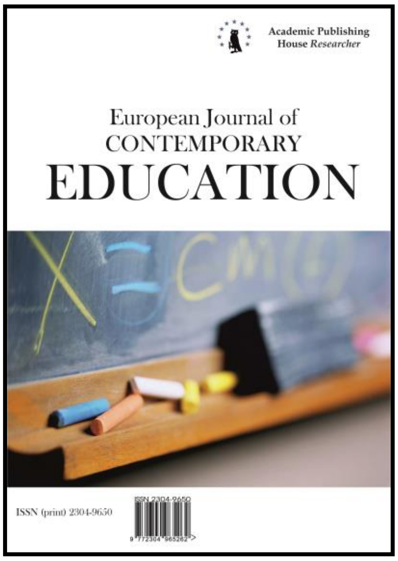

Lower-Order Mathematical Thinking Skills in Finance, from the Viewpoint of Financial Employees in the Iranian Bank of Industry and Mine

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Abstract

In this paper, lower-order mathematical thinking skills within finance were studied from the viewpoint of financial employees in the Iranian Bank of Industry and Mine. To conduct this research, a questionnaire was developed after reviewing lower-order mathematical thinking skills in finance. In accordance with the revised Bloom's taxonomy, the skills considered in the questionnaire were "remembering mathematics in finance", "understanding mathematics in finance", and "applying mathematics in finance". In order to develop the questionnaire, we conducted interviews with employees and scholars, then a suitable sample familiar with mathematics and finance, consisting of 141 bank employees, was studied. Descriptive and inferential statistics were used for data analysis. Our findings show a hierarchical relationship between the first three mathematical thinking skills in finance, which confirms the revised Bloom's taxonomy. In addition, the attitudes of participants were positive concerning the importance of these skills. Participants believed that, in order to achieve proper functioning, it is essential to improve the skills of financial employees. The results were analysed with a T-test and ANOVA. This showed that the gender, position, experience, department, degree, and field of study of participants did not affect their attitudes. This research indicates that, for the successful utilisation of skills, it is essential to form an effective relationship between mathematical science and its practical application in the banking world. It is recommended to hold on-the-job training courses for financial employees in banks to empower them to use their computational skills.

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1. Introduction

Mathematical thinking is an issue that has attracted many mathematics educators. There is a large body of varied literature including various conceptions of mathematical thinking, but there is a general agreement among researchers that the most important goal of mathematical education is to develop the ability to think correctly (Polya, 1969). Some scholars also studied mathematical skills in the workplace (Bakker et al., 2011; Hoyles et al., 2002). So far, very little attention has been paid to the role of mathematical thinking skills in financial affairs. In this paper, we are particularly interested in examining the hierarchical relationship between the first three levels of mathematical thinking skills (based on the revised Bloom's taxonomy), due to the mathematical nature of the topics and financial affairs. We focus on identifying skill gaps in financial affairs in one of the banks in Iran, the Bank of Industry and Mine (a developmental bank), statistically comparing the means of demographic characteristics of the samples. The aim of this study is to survey the views of the bank‘s employees on lower-order mathematical thinking skills in financial affairs, in order to better identify a curricula framework for learning in schools and banks. Another aim of this study is to survey the significant difference between demographic characteristics of participants regarding the importance of lower-order mathematical thinking skills in finance, based on the revised Bloom's taxonomy.

The literature study begins with information on adult mathematics education and proceeds to theories of lower-order mathematical thinking skills (Bloom, 1956; Anderson et al., 2001; Tuluram, 2013), then mathematical skills especially in finance and banking, ending with lower-order mathematical thinking in finance how to enhance professional skills of those in banking and finance. We use descriptive and inferential statistics to describe the results, and identify guidelines for lower-order mathematical thinking skills at work in order to satisfy the educational needs of bank employees.

Two stages were considered, lower-order and higher order mathematical thinking skills, which were based on the revised Bloom's taxonomy (Anderson et al., 2001). Here, we only address lower-order thinking skills in a bank. A separate paper addresses higher-order mathematical thinking skills in the bank. As one of the main tasks of banks is to have good consistency across levels, we used the revised Bloom's taxonomy integrated with Stacey‘s view for developing a questionnaire. Question 1: Is there a hierarchical relationship between the constructs of lower-order mathematical thinking skills in finance? In order to examine finance-related employees' acceptance/ resistance attitudes toward the lower order mathematical thinking skills in the Iranian Bank of Industry and Mine, we asked Question 2: How much does remembering mathematics need to be improved to enhance the calculation skills of financial users in the banking industry? Also, Question 3: How much does understanding mathematics need to be improved to enhance understanding and financial problem-solving skills of financial users in the banking industry? And Question 4: How much does applying mathematics need to improve to increasing work problem-solving skills of financial users in the banking industry? Then, in order to test for significant differences between the means of demographic characteristics of the samples, we tested further questions, starting with Question 5: Is there a significant difference between the means of viewpoints of female and male participants regarding the importance of lower-order mathematical thinking skills in finance? Also, Question 6: Is there a significant difference between the means of the viewpoint of participants in different positions (managers or experts) regarding the importance of lower-order mathematical thinking skills in finance?; Question 7: Is there a significant difference between the means of participant viewpoints with different levels of education on the importance of lower-order mathematical thinking skills in finance?; Question 8: Is there a significant difference between the means of viewpoints of participants from different fields of study on the importance of lower-order mathematical thinking skills in finance?; Question 9: Is there a significant difference between the means of viewpoints of participants with different work experience on the importance of lower-order mathematical thinking skills in finance?; and Question 10: Is there a significant difference between the means of viewpoints of participants in different departments regarding the importance of lower-order mathematical thinking skills in finance?

2. Literature review

In this paper, the literature study indicates the importance of interdisciplinary research in the sciences of mathematics and finance.

Mathematical thinking

Several authors have attempted to define mathematical thinking, but at the time of writing, there was still no accepted definition. Har's (2011) definition offers a good start to understanding the nature of mathematical thinking – "A good critical thinker (a) raises vital questions and problems, formulates them clearly and precisely; (b) gathers and assesses relevant information, using abstract ideas to interpret it effectively comes to well-reasoned conclusions and solutions, testing them against relevant criteria and standards; (c) thinks open-mindedly within alternative systems of thought, recognizing and assessing, as need be, their assumptions, implications, and practical consequences; and (d) communicates effectively figuring out solutions to complex problems" with supporting evidence and proofs (Tularam, 2013). Some general approaches to mathematical thinking can be distinguished. In one approach, educators such as Stacey (2006) believe in using mathematical thinking skills in relation to other scientific fields such as science, technology, and economics. They see these skills in the context of their relationship with everyday life, in communication with ideas and phenomena, and in certain kinds of modeling. These educators believe that applying maths in real-life problem-solving has a key role in improving conceptual learning, and can be used as a special tool for fostering understanding and developing human control (Burton, 1984). From such a perspective, there will be good headway made towards reality-based mathematics and mathematical literacy. In another approach, "problem-solving" is considered as the heart of mathematics (Halmos, 1980). Shoenfeld (1987) investigated the nature of mathematical thinking after a book, "How to solve it?", was written by Polya (1957). In Schoenfeld's view, analysis, abstraction and composition of phenomena from the perspective of mathematics are known as mathematical thinking. In her idea, categories of: "core knowledge, problem solving strategies, effective use of one's resources, having a mathematical perspective, and engagement in mathematical practices" are fundamental aspects of thinking mathematically. Schoenfeld (1992) stated a principled explanation of how the varied aspects of mathematical thinking and problem-solving fit together; there does appear to be an emerging consensus about the necessary scope of inquiries into mathematical thinking and problem solving.

Some scholars, such as Rahimi (2016), believe that, although mathematical thinking skills are not seen as unrelated to the use of mathematics in everyday life and problem-solving skills, an attempt is made to educate students who are mathematical thinkers rather than good problem-solvers. In one of the more important approaches, Bloom's taxonomy (1956) provided a classification of "lower" and "higher" elements of thinking. As with all taxonomies, it is hierarchical. The taxonomy organised the elements of thinking in descending order (Stratton, 1999).

Bloom's taxonomy helps educators not only to understand the levels of learning, but also to determine the educational goals of lessons and the depth of lesson discussions. Bloom studied cognition and meta-cognition using cognitive, psychomotor, and affective domains. The cognitive domain includes knowledge, comprehension, and application, as well as analysis, synthesis, and evaluation. In the cognitive domain, knowledge and the other primary elements of thinking are themselves divided into sub-elements. According to the taxonomy, we think in different levels of complexity.

Using the general term 'knowledge', Bloom's Taxonomy refers to the sorting involved in memorisation. The taxonomy refers to knowledge as "lower-order" thinking, to distinguish it from the "higher order" thinking involved in analysis, synthesis, and evaluation. Comprehension and application are classified as "lower-order" thinking skills. We comprehend when we can recite material we have memorised. Comprehension is a step up the hierarchy from mere memory; when we comprehend we grasp all the details of what we remember in a whole. Comprehension is a gestalt of what we have memorised. Application, too, is regarded as a lower-order thinking skill by the taxonomy. Application is the use of abstract ideas in concrete situations (Stratton, 1999). The higher-order thinking skills are the abilities to analyse, synthesise, and evaluate, which also includes a number of reflective thinking skills. In Bloom's taxonomy, analysis refers to recognising patterns suggested by facts, while synthesis involves producing something new, and evaluation includes judging the quality of a solution or theory.

The names of six major categories were later changed from noun to verb forms; thus, the terms of the revised Bloom's taxonomy (Anderson et al., 2001) include remembering, understanding, applying, analysing, evaluating, and creating mathematics in finance. According to the taxonomy, we think in different levels of complexity.

In this paper, the thinking levels based on the revised Bloom's taxonomy (Anderson et al., 2001) are as follows:

Table 1. Revised Bloom's Taxonomy of Lower-Order Mathematical Thinking

Level	Cognitive domain	Description	Sub-scales
1	Remembering	This category consists of memories that were obtained from previously learned information by recalling facts, terms, basic concepts and answers. Basically, the person has to input and store into the mind with appropriate information.	collect, read, name, state, select, identify
2	Understanding	This category emphasises the ability to demonstrate understanding of facts and ideas by organising, comparing, translating, interpreting, giving descriptions and stating the main ideas. The main elements in an understanding category must allow a person to state a problem in one's own terms.	contrast, compare, explain, interpret, summarise, distinguish
3	Applying	This category emphasises the ability to use new knowledge or concepts and solve the problems in new situations, or unprompted use of an idea by applying acquired knowledge, facts, techniques and rules in a novel way.	apply, solve, determine, compute, use, demonstrate

It can be said with high probability that the above thinking skills are almost "routinely" practised during mathematical learning in each classroom, university lecture or during tutorials and workshops around the world. The 2007 global crisis has concentrated on financial thinking, generally, and mathematical teaching of finance, particularly, for the lack of skills in financial personnel (Tularam, 2013). This research considers mathematical thinking in finance through teaching mathematics on the basis of Bloom's taxonomy integrated with Stacey's view.

The role of lower order mathematical thinking skills in banking and finance

In the present century, employment status and economic competition have a direct relationship with general literacy and mathematical literacy, science and technology (Milgram, 2007). There is also a gap between problem-solving approaches, based on the application needed on the job, and the traditional basic set of skills in the educational curriculum (Buckingham, 1997; Strasser, 1998; FitzSimons, 1998). According to the National Research Council (1999, cited in Lesh, Zawojewski, 2006), technological changes will continue to alter skills and eliminate jobs, although skill requirements for some jobs can be re-used, the changes in technology are more likely to increase skill requirements and modify them in ways to give greater emphasis to cognition, communication, and interaction. There is a difference between school mathematics and workplace mathematics that is critical to a new perspective on problem solving (MSEB, 1998; Oakes et al., 2003; Magajna, Monaghan, 2003, cited in Lesh, Zawojewski). According to Steen (2003), school mathematics is complex but used in simple problems, whereas workplace mathematics is simple but used in complex problems.

Whilst content is still essential in engineering education, Cardella (2008) states the importance of "mathematical thinking". The curriculum documents of the SEFI Mathematics Working Group have changed from contents to outcomes to competencies.

Banks often recruit graduates from disciplines such as accounting, economics, finance, engineering, and mathematics. Here, the fields of economics finance, accounting and banking are briefly reviewed. Examining the literature so far; it is seen that investigations have been generally focused on "applying mathematics" in economics (Debreu, 1986; Alizadeh et al., 2014; Dusek, 2008; Alpha C. Chiang, 1984; Pourkazemi, 2002), in finance (Rahnamay Roodposhti et al., 2010, 2016; Alexander, 2008; Abdoh, 2007 and Abolhasani et al., 2015), and in accounting (Hendriksen and Berda, 1992; Rahnamay Roodposhti et al., 2012; Amani, Davani, 2013; Kabir, 2005; Verrecchia, 1982).

Computers are able to process non-intellectual operations exactly as planned, but cannot recognise the suitability of different solutions. Employees can then understand the applications of mathematical operations (Rahnamay Roodposhti et al., 2010). Bakker et al., (2011) examined the challenges of communication between a mortgage company and its customers in terms of crossing boundaries between communities. They developed software to model or reconstruct actual practice, using data drawn from a current account mortgage (CAM), which integrated a regular current account with the property mortgage. Their research suggested that the intervention with the technology enhanced boundary objects (TEBOs), helped employees to develop a better understanding mathematics behind the loans given to mortgage customers and, as a result, helped to improve the company's communication with customers. Hoyles et al. (2010) focused on two pension companies and a mortgage company in the United Kingdom, all dealing with annuities-based scenarios. They identified several gaps in the knowledge of sales and service employees, including inadequate understanding of the growth of money and the notion of present-value of money, of the key variables and of their relationships in mortgage scenarios.

Two main tasks of banks in Iran are monetary resource mobilisation and giving loans deployed with the cooperation of all executive departments in banks (Behmand, Bahmani, 2007). Banks are always trying to create a competitive advantage to obtain additional resources through bank deposits. When banks lend facilities to customers, credit reviews ensure that a project has sufficient justification (technical, financial and economic), with the economic activity of the specific project being autonomously responsible for repayment or settlement of obligations (Hedayati et al., 2003). In many financial affairs, financial employees need mathematical data and equations in the field of arithmetic and algebra. Financial issues can be modelled for banks by using algebraic equations and mathematical symbols (Abolhasani et al., 2015), so mathematical thinking skills in finance would require an extensible domain of mathematical knowledge and its conceptual comprehension. Studies show the importance of mathematical applications in the financial field and the necessity of attention to mathematical thinking in financial affairs, especially in banking. Some think that more attention into mathematical learning is necessary in financial affairs (especially in banking).

Niss (2003) identified the mathematical categories of thinking mathematically; posing and solving mathematical problems; mathematical modelling; mathematical reasoning; representing mathematical entities; handling mathematical symbols and formalism; communicating about mathematics; and making use of aids and tools. Kent and Noss (2002) distinguish two approaches as "doing" and "understanding" mathematics. Context and the activity in which mathematical understanding takes place are essential to this, as employees must make mathematical sense of situations quite different from their formal mathematical education (Bakker et al., 2006). Computers perform most calculations, but decisions based upon output are prone to serious errors if the user does not understand the underlying mathematics (Gravemeijer, 2012). On the one hand, it seems that less mathematical knowledge is needed as computers take over a growing number of mathematical tasks; on the other hand, for "mathematics consumers", there is an increased need to be able to handle and understand quantitative information (Gravemeijer, 2013; Levy, Murnane, 2007). Bialik and Kabbach (2014) agree with this view and state it is most likely that higher-order thinking skills support mathematical skills, and not the reverse. Huang, Ricci, Mnatsakanian (2016) recommend "thinking through math", with meaningful mathematical experiences to enhance critical thinking.

The banking research here presented two challenges. The first was to understand what kind of mathematics was at stake for the bank employees. The second was to find a valid and effective way to run a training programme for employees to enhance their understanding of the relevant mathematics, as it was widely recognised that some kind of formal 'banking mathematics' would not adequately achieve this goal (For a full account of this work, see Noss, Hoyles, 1996b). Reich (1992) described professional workers as 'symbolic analysts', compared with 'routine producers' who follow a standardised, repetitive set of procedures for the manufacture of a product or the delivery of a service. According to Reich (1992), more and more professional workers tend toward being symbolic analysts, who solve, identify and broker problems by manipulating symbols.

Hoyles et al. (2002) did a survey in financial companies (three case studies) where they identified the key mathematical skills required of a large number of employees as: multi-stage calculations including percentages; the ability to understand relationships between variables; the ability to read, interpret and transform data from charts and spreadsheets; the ability to create formulae; confidence in identifying, appreciating and using concepts of risk and probability; and the ability to use approximations, estimates and formal probabilities to model likely events. One case study (Kent et al., 2007), designed experiments set in the financial services sector, focused on the annual pension statement, using a boundary object designed to facilitate boundary crossing between the company and customers. Although the mathematics involved in finance is superficially similar to secondary school mathematics, Kent et al. (2007) observed that in the workplace context, every mathematical procedure, no matter how simple, is part of a whole range of decisions and judgments about complex processes or products. Employees must be able to mathematically appreciate computer outputs, interpret them in their context, and recognise which components are hidden by the IT system. They also need to be able to reason about the mathematical models embedded in the system in terms of the key relationships between product variables (e.g., percentage rates, management fees, and sales commissions) and their affect on outputs presented in the form of graphs or tables. FitzSimons (2013) showed how contextual knowledge of finance links with mathematical knowledge and knowledge of learners' thinking in the modelling of time in financial scenarios. The modelling conventions greatly simplify the complexity of dealing with time in financial scenarios; however, students and learners who do not yet know these conventions, and thus work from an everyday understanding of banking processes, are likely to produce their own models that do not fit with convention and may therefore be disregarded by teachers. Solutions need to be accompanied by knowledge that the models do not take into account the daily workings of the world of banking. The evidence found by Jappelli, Mario (2013) showed that improving mathematical skills early in life will eventually raise a households' financial literacy and wealth accumulation. They also showed that the current level of financial skills and wealth are strongly correlated with a measure of mathematical skills at school age available in SHARELIFE. They treat aggregate data in a similar way and find that PISA scores in mathematics are strongly correlated with country-wide indicators of financial literacy supplied by business leaders as well as national savings.

In fact, in many occupations, learned knowledge and skills rapidly become out of date. This has created a requirement for continuous professional development, i.e., the process of identifying previous learning and training needs (Cartwright, 2003). Timothy (2011) mentioned that the credit crisis had an effect on banking affairs. Some banks, like J.P. Morgan, make good decisions in a credit crisis because they employ mathematicians, while others do not and then suffer from the crisis. The development of mathematical knowledge in banking is not an exception and teaching mathematical knowledge is essential in banking. The subject "competence programs" has been receiving attention in developing different educational fields. In the latest edition of Alpers et al. (2013), the main message is that, "although contents are still important, they should be embedded in a broader view of mathematical competencies". In such a program, one should favorably show their competence on jobs, in addition to achieving knowledge, in accordance with national or international standards. The skills-gap is the difference between the required skills to perform determined tasks and skills that employees actually have (Fig. 1). If this gap is determined, it can be resolved using educational methods (Cartwright, 2003).

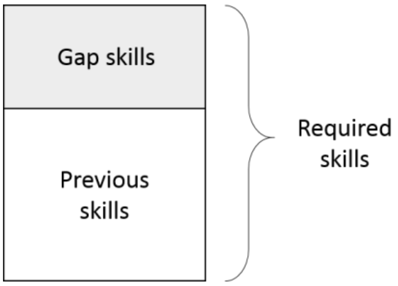

Fig. 1. Required skills

The items considered as lower-order mathematical thinking skills in finance, based on the revised Bloom's taxonomy, include remembering mathematics in finance, understanding mathematics in finance and applying mathematics in finance (Fig. 2).

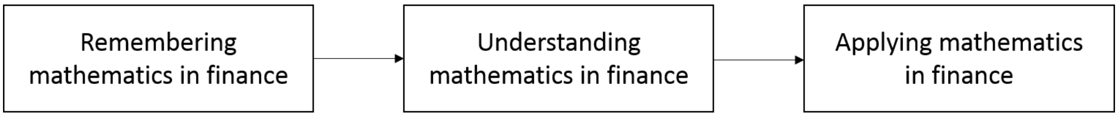

Fig. 2. Conceptual Framework

3. Method

In the present study, according to the views of employees, we investigated the relationship between the first three levels of mathematical thinking skills in finance, the gaps in lower-order mathematical skills in financial affairs, and any significant relationships between demographic characteristics of participants, based on the revised Bloom's taxonomy.

Participants

The data was obtained from a bank providing financial services to special customers in sections of the Iranian Bank of Industry and Mine. The sample was selected purposively (those familiar with mathematical and financial knowledge) based on the questionnaire, to assess the extent of individuals' familiarity with and acceptance of a modern mathematics education regardless of their situation. Anonymous questionnaires were filled by the participants in 2016. Six returned questionnaires were discarded because they did not answer most of the questions and finally 141 acceptable responses were received. In order to increase the accuracy of the tests, weighting of observed data was performed according to demographic characteristics (See Appendix1). Weighting participants was accomplished by considering positions, work experience, departments, education degree and their field of study.

Questionnaire

The questionnaire was developed in accordance with standard questionnaires in this field. We developed this questionnaire according to literature, with a purpose to examine the hierarchical relationship of the three lower-order mathematical thinking skills, and also to evaluate lower-order mathematical skill-gaps in finance from the view of the banking industry. Finally, we compared significant differences between demographic characteristics of participants.

The items pool was refined through the expert opinion of seven Iranian academics following the analysis of the pilot data and a seminal questionnaire was further refined. Content validity of this questionnaire was confirmed by several professors in mathematics and finance.

We depicted three latent variables of mathematical thinking skills in finance, based on the revised Bloom's taxonomy (2001). The questions were ordered for evaluating staff's attitudes towards lower-order mathematical thinking skills in finance, as detailed in Appendix 2. Based on the questions, the items were specified and analysed, as in Table 2.

Table 2. Items of the questionnaire

Construct	Item	Description
Remembering mathematics in finance	KN1	Mental calculations of 4 basic arithmetic operations
	KN2	Remembering mathematics knowledge in regulating financial data
	KN3	Remembering mathematics knowledge in resolving Bank likely reconciliation
	KN4	Remembering mathematics knowledge for determining relationships among financial variables
	KN5	Remembering mathematics knowledge in finding reasonable solutions when encountering financial problems
Understanding mathematics in finance	CO1	Better understanding the calculations in computing applications
	CO2	Understanding mathematical applied problems in finance for improving the quality of financial operations
	CO3	Understanding math calculations in finance to improve communications with customers
	CO4	To better understand relationships among financial indices through the relationships among mathematical variables
	CO5	Understanding mathematical applied problems in finance to improve employees' decision-making
Appling mathematics in finance	AP1	Application of mathematics in finance to do financial calculations of investment plans
	AP2	Application of mathematics in finance to be able to solve complicated financial problems
	AP3	Application of mathematics in Finance to discount future prices
	AP4	Application of mathematics in Finance to reduce operational risk
	AP5	Application of mathematics in Finance to improve financial information monitoring

The finance-related employees were asked to respond to an anonymous questionnaire containing **15** useful and short questions, each with five response choices using a Likert scale. The respondents were asked to comment on each of the specified expressions using the Likert scale (including the five choices: very much, much, average, little, and very little) as both the “status quo” and “importance value”. Then Cronbach's alpha was used for the reliability test with 65 participants; its values were observed to be more than 0.7 for all inquiries.

Analysis method

In order to identify employees’ attitudes toward the importance of each criterion, their responses were evaluated. First, factor analysis of lower-order mathematical thinking skills indicated that all factor loadings were greater than 0.4, which was statistically significant (at an error level of 0.05, T-values were greater than 1.96); thus, there was no need to eliminate any of the items.

Second, the method of descriptive statistics was employed in order to determine skills-gaps in mathematical thinking in finance, according to participants’ attitudes. Research data were statistically processed using $SPSS_{21.0}$ and Microsoft Excel. Descriptive statistics, means and standard deviations, were calculated. Skewness and kurtosis coefficients were calculated to assess univariate normality. We calculated the reliability of each dimension given by the index of Cronbach‘s alpha for internal consistence. Here, the weighted responses for each respondent were thus specified (weighting calculations made with Microsoft Excel). Next, the mean values of weighted responses were obtained. The responses were skewed towards very much or very little, which demonstrates that the mean is an appropriate variable to use in analyses for this study.

Third, the student t-test for independent samples was used to compare the means of the group of female participants with the group of male participants, and the group of manager participants with the group of expert participants, regarding the importance of lower order math thinking skills in finance, with the aim of checking whether the two groups were homogeneous.

A one-way ANOVA was then used to compare the means of groups with different levels of education degree, field of study, and work experience regarding the importance of lower-order mathematical thinking skills in finance, with the aim of checking whether these several groups were homogeneous.

4. Findings

This section contains an overview of the responses of financial staff in the banking industry to the questionnaire, with the questionnaire items analysed in three phases.

Phase 1. Structural equation modeling (SEM)

Validity of this questionnaire is estimated using structural equation modelling (SEM), through confirmatory factor analysis (CFA), which showed that the expected factor structure is correct: $\chi 2$ (87) = 125.21, p=0.00459; non-normed fit index (NNFI) = 0.97; comparative fit index (CFI) = 0.98; root mean square of approximation (RMSEA) = 0.056. All subscales demonstrated acceptable levels of internal consistency ranging from 0.40 to 0.85.

In addition, *factor* loadings for observable variables (dimensions) and path coefficients between the constructs are illustrated in Fig. 3.

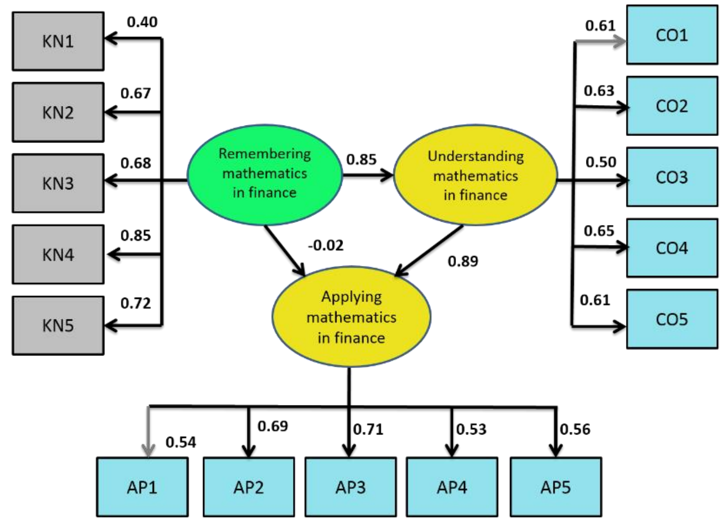

Fig. 3. Structural model with standardised path estimates from the asymptotic method.

As seen in the above Figure, fitness indices of the model are found to be acceptable; thus, the compatibility in the conceptual model is confirmed by the gathered data. Except for the effect of remembering mathematics in finance on understanding mathematics in finance (T-value of -0.06), other effects were statistically very significant (T-values of more than 1.96).

Phase 2. The Results of the Questionnaire Items (Based on the Items)

In this section, the mathematical thinking skills needed in the banking industry (the lower-order mathematical thinking skills in financial affairs, based on the revised Bloom's taxonomy) are closely investigated based on the views of the expert employees. For this purpose, efforts were made to identify what mathematics are required for this group of employees at work.

In order to become familiar with the views of participants, weighted means of their responses to the questions are presented in Table 3, based on means for each item (the "status quo" and "importance value" of each criterion). The weighted Standard deviation and Cronbach's alphas for the items are also shown in Table 3.

Table 3. Weighted Means & Standard deviation & Cronbach's alpha for the questionnaire items

Items	Mean (M)			Standard deviation (SD)		Cronbach's alpha	
	Importance	Status que	Gap	Importance	Status que	Importance	Status que
KN1	4.00	3.05	0.95	0.98	1.15	.887	.935
KN2	3.92	2.79	1.13	0.85	0.87	.873	.928
KN3	3.87	2.81	1.06	0.92	0.92	.872	.930
KN4	4.00	2.81	1.19	0.77	0.93	.867	.927
KN5	4.09	2.77	1.32	0.8	0.99	.872	.928
CO1	4.27	3.02	1.25	0.76	0.93	.874	.927
CO2	4.07	2.84	1.23	0.79	0.88	.873	.927
CO3	3.49	2.57	0.92	1.03	0.88	.880	.932
CO4	4.12	2.81	1.30	0.79	0.92	.873	.928
CO5	3.84	2.63	1.21	0.91	0.86	.875	.931
AP1	4.18	3.09	1.09	0.75	0.91	.879	.932
AP2	3.96	2.71	1.26	0.82	0.92	.874	.931
AP3	4.06	2.96	1.10	0.85	0.93	.873	.931
AP4	3.86	2.74	1.13	0.89	0.84	.877	.931
AP5	4.00	2.83	1.17	0.8	0.85	.876	.929

The reliabilities of the items were identified using Cronbach's alpha method, with values over 70 % for all the questions which were thus confirmed.

The employees' responses to the question of "remembering mathematics in finance" show that, in their view, mental calculations using four basic arithmetic operations are effective for doing financial calculations (4.00). They know that remembering mathematical knowledge will help financial employees in regulating financial data (3.92) and resolving bank reconciliation (3.87). They expect that remembering mathematics provides them with a reasonable frame in which to determine the relationship between financial variables (4.00) and help employees to find reasonable solutions for financial problems (4.09). Participants believe that their mathematical knowledge needs to be strengthened in order to improve at financial calculations. The employees' responses to questions of "understanding mathematics in finance" indicated that they believed understanding applied to problems of mathematics promoted staff's understanding in computing applications (4.27), quality of financial operations (4.07), and understanding how mathematical computations affect improvements in communication with customers (3.49). They are well aware that understanding the relationships of mathematical variables is effective in understanding the relationships of financial indicators (4.12). They know that understanding mathematics is effective in improving the decision-making of financial employees (3.84). The employees' responses to question of "applying math in finance" indicate the fact that, from their viewpoint, applying mathematics is effective in financial calculations for investment plans (4.18), the ability to solve complicated financial problems (3.96), calculations of discounted future prices (4.06), reducing operational risk (3.86), and monitoring financial information (4.00).

Under this methodology, the average level of importance of lower-order mathematical thinking ranges from 3.49 to 4.27 points. Also under this methodology, the average level of the status quo of lower-order mathematical thinking ranges from 2.57 to 3.09 points.

The overall schema on three levels of lower-order mathematical thinking skills based on the revised Bloom's taxonomy is shown in Figure 4, according to the means of responses.

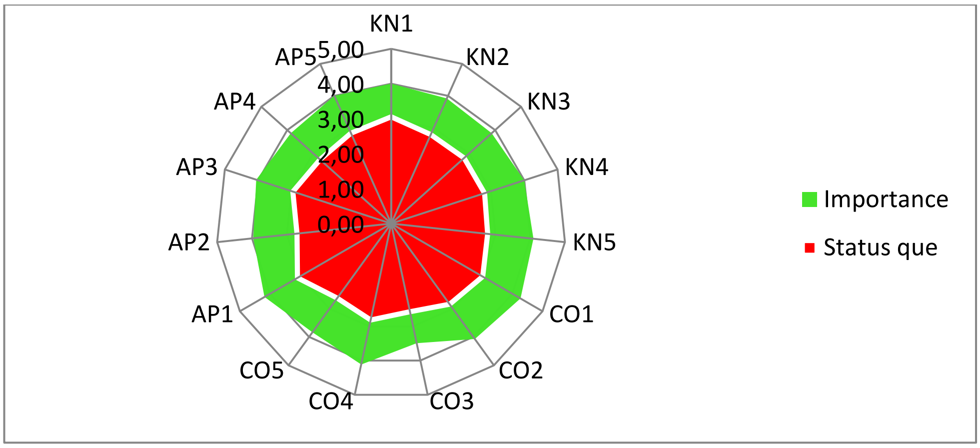

Fig. 4. The overall schema on lower-order mathematical thinking skills

It revealed that, regarding financial personnel, there are skills-gaps for all items of lower-order mathematical thinking skills in finance.

Results of the Questionnaire Items (Based on lower-order mathematical thinking)

The questions could be an appropriate representation of financial personnel's opinions in the banking industry, their familiarity with mathematical thinking skills, and the role of lower-levels of mathematical thinking skills in empowering them in their financial affairs. In Table 4, the means of the items related to lower-order mathematical thinking levels are shown based on the weighted means of personnel's responses at each of these levels.

Table 4. The second weighted means of staff responses to the questionnaire

Mean 2	KN	UN	AP
Importance	3.98	3.96	4.01
Status que	2.85	2.84	2.85
Need for improvement (Gap)	1.13	1.12	1.16

Above Table demonstrates the fact that, from the participants' point of view, skills-gaps for lower-order mathematical thinking in finance are 1.13 at the level of understanding mathematics in finance, 1.12 at the level of remembering mathematics in finance, and 1.16 at the level of applying mathematics in finance. The results indicate that from the point of view of financial employees, the largest skills-gap is in applying mathematical thinking skills in finance, while they believe that the smallest skills-gap is in understanding mathematical thinking skills in finance.

Phase 3. The results of the INDEPENDENT SAMPLES T-TEST and ANOVA are shown in Table 5.

According to the Table 5, we found that:

- There are no significant differences (Sig= 0.49>0.05) between the Groups (men, woman) regarding the importance of lower-order mathematical thinking skills in finance.
- There are no significant differences (Sig= 0.87>0.05) between the Groups (manager, expert) regarding the importance of lower-order mathematical thinking skills in finance.
- There are no significant differences (Sig= 0.72>0.05) among the Groups (bachelor, master, Phd) regarding the importance of lower-order mathematical thinking skills in finance.
- There are no significant differences (Sig= 0.48>0.05) among the Groups (Finance-related, Accounting, Economy, Management, Mathematics, Engineering, Law, Other) regarding the importance of lower-order mathematical thinking skills in finance.
- There are no significant differences (Sig= 0.41>0.05) among the Groups (Less than 5 years, 5 to 10 years, 10 to 15 years, 15 to 20 years, 20 to 25 years, More than25 years) regarding the importance of lower-order mathematical thinking skills in finance.

• There are no significant differences (Sig= 0.99>0.05) among the Groups (Financial affairs, Branch, related financial affairs, Other) regarding the importance of lower-order mathematical thinking skills in finance.

Table 5. Results of INDEPENDENT SAMPLES T-TEST and ANOVA

INDEX	DIMENSION	N	Mean	Sig.	Method
Gender	Woman	43	61.3953	.492	T TEST-INDIPENDENT SAMPLES
	Man	96	58.8958		
Position	Manager	77	59.6753	.871	
	Expert	63	59.4762		
Degree	Bachelor	33	60.4242	.718	ANOVA
	Master	93	59.5806		
	PHD	15	58.4667		
Field of study	Finance-related	4	63.5000	.481	
	Accounting	16	57.9375		
	Economy	18	59.7778		
	Management	41	58.6829		
	Mathematics	10	64.3000		
	Engineering	46	59.9565		
	Law	3	61.0000		
	Other	2	55.5000		
Work experience	Less than 5 years	5	58.4000	.412	
	5 to 10 years	33	59.1515		
	10 to 15 years	55	59.5091		
	15 to 20 years	22	58.0000		
	20 to 25 years	7	59.8571		
	More than 25 years	19	63.1579		
Departments	Financial affairs	49	59.8776	.990	
	Branch	31	59.8387		
	Related financial affairs	60	59.4833		

5. Discussion

In Phase 1, the study of the data implies that the personnel believe that the remembering mathematics in finance affects understanding of mathematics in finance, remembering mathematics in finance affects applying mathematics in finance, but remembering mathematics in finance is not effective when applying mathematics in finance using the asymptotic method. The results indicate that the relationship between the constructs of lower-order mathematical thinking in finance is hierarchical.

In Phase 2, analysis shows staff believe that, in order to better the performance of employees in doing calculations quickly and accurately, resolving bank reconciliation, regulating financial data, and providing a reasonable frame to determine the relationships among financial variables and thus finding a reasonable solution when encountering financial problems, skills-gaps in the field of "remembering mathematics in finance" need to be improved. They believe that financial employees should be able to express a financial problem as a mathematical problem.

With remembering mathematical knowledge, one could be successful in carrying out computational problems.

The results show that from the employees' perception, the effects of the skill of "understanding mathematics in finance affairs" for improving the ability for understanding and solving problems are important. From the viewpoint of employees, it is essential that this skill is improved to foster financial understanding and employees' problem-solving. They know that understanding mathematics is effective for improving understanding of computations in computing applications, the quality of operations in banks, communication with customers, and a better understanding of relationships between financial indicators as a result of their decision-making. They believe that the skills-gap would be covered.

The results show that participants believe in applying the lower-order mathematical thinking skills to improve the financial performance of employees and think that, broadly, the employees' skills in financial affairs need to be improved.

The results show that participants were well aware of the effects of applying mathematics in improving skills at work through problem solving. They believe that in order to improve an employees' performance, it is necessary to strengthen the third level of mathematical thinking skills in such a way that they can improve their ability to carry out financial calculations for investment plans, the complicated problem-solving of finance, calculations of discounted future prices, reducing operational risk, and monitoring financial information.

In Phase 3, the results show no significant differences between the Groups, according to demographic characteristics regarding the importance of lower-order mathematical thinking skills in finance.

Overall, this study confirms the hierarchical relationship between the first three mathematical thinking skills in finance, based on the revised Bloom's taxonomy (2001), in banking. The results also show that, in the viewpoint of participants, lower-order mathematical thinking skills in finance need to be strengthened. Results are compatible with other studies which show a gap between the application-based method and problem-solving approach required in employment and the traditional basic set of skills in the educational curriculum (Buckingham, 1997; FitzSimons, 1998; Strasser, 1998); we cannot expect high school graduates who were taught pure mathematics to be able to solve real-world problems using mathematical knowledge (Niss et al., 2007).

This study has revealed the importance of understanding and applying mathematics in finance. Previous studies have also argued the importance of the understanding mathematics in finance in the accounting and auditing professions (Rahnamay Roodposhti et al., 2012; Hoyles et al., 2010; Amani, Davani, 2013) and the importance of applying mathematics in finance (Abdoh, 2007, 2014; Rahnamay Roodposhti et al., 2010, 2016; Tularam, 2013; Johnson, 2010).

The views of participants in this study, regarding the need for improving their lower order mathematical thinking skills in financial affairs, lend support to previous findings by Jappelli et al. (2013), which showed that improving mathematical skills early in life will eventually raise households' financial literacy and wealth accumulation, and that the current level of financial skills and wealth are strongly correlated with a measure of mathematical skills at school age.

This study is in line with Hoyles et al. (2002) who identified multi-stage calculations including percentages, the ability to understand relationships between variables, and interpret and transform data from charts and spreadsheets to model likely events as some of the key mathematical skills required of a large number of employees.

On the other hand, Beiker et al., (2010, 2011) found that communication between agents and potential customers was mostly concerning symbolic artefacts. They showed that a better understanding the mathematics which hindered mortgage loans was developed by employees by intervening with technology-enhanced boundary objects. It is recommended the educational system be modified with the mathematical curriculum, especially for vocational courses, tailored to the needs of the workplace (especially in finance).

6. Conclusion

The results helped to answer the question "Is there a hierarchical relationship between the constructs of lower-order mathematical thinking skills in finance?" According to the SEM results, "mathematical thinking skills in finance" affect "understanding mathematics in finance", and “understanding mathematics in finance” affects “applying mathematics in finance”; this implies that there is a hierarchical relationship between the constructs of lower-order mathematical thinking skills in finance.

Results helped to answer the question “How much does remembering mathematics need to be improved to enhance calculation skills in financial users in banking?" Data analysis shows that, from the viewpoint of the participants, remembering mathematics to enhance their computational skills (doing quick and accurate calculations in finance, regulating financial data, determining relationships among financial variables, resolving bank probable reconciliation, and finding reasonable solutions when encountering financial problems) needs to be improved. The current research addressed the question of "to what extent does understanding mathematics need to be improved to increase the ability of understanding and problem-solving in financial users in banking?” Employees believe that understanding mathematics in financial affairs needs to be improved to better understand computations in computational software and relationships between financial indicators, in order to promote the quality of banking operations, to foster the communication with customers, and to empower employees in making decisions. Finally, the question is answered of "to what extent does applying mathematics in financial affairs need to improve to increasing work problem-solving skills in financial users in banking?" The financial employees who answered the aforesaid question expect that applying mathematics in financial affairs needs to be improved when doing financial computations of investment plans, solving complicated problems of finance, calculating discounted future prices, reducing operational risk, and monitoring financial data.

The results helped to compare the differences between the means of demographic characteristics of the samples. According to the results of the T-test and ANOVA, we find no significant differences between the Groups (Gender, Position, Experience, Department, Degree, Field of Study) regarding the importance of lower-order mathematical thinking skills in finance; this is reasonable because all participants were aware of the items of lower-order mathematical thinking and were educated during their degrees.

Generally, the results show that employees have positive attitudes towards using lower-order mathematical thinking skills in financial affairs and believe that there are skills-gaps in all items *of lower-order mathematical thinking in financial affairs. The lower-order mathematical thinking skills should be strengthened in financial affairs. Considering* current rapid changes in technology, it seems essential to integrate the current mathematical curriculum with mathematics at work (financial affairs) in order to determine a suitable educational content for schools in such a way that future school graduates can properly apply mathematics in financial affairs. The results are useful in identifying the intended items for these skills and, in fact, can produce a guideline for the provision of educational content in studying for a financial career so that learning resources will improve. The results also show that lower-order mathematical thinking skills in financial affairs need to be improved in the Iranian Bank of Industry and Mine, as indicated by the viewpoints of employees. A programme for teaching mathematics at work is suggested, as well as establishing laboratory and virtual workshops for creating a learning environment tackling the skills-gaps in lower-order mathematical thinking skills in financial affairs (especially, banks). It seems that one of the biggest reasons for skills gaps among financial employees is a lack of education related to mathematics at work during their study; therefore, it is suggested that the educational content of mathematics in the school curriculum be customised and adjusted in accordance with mathematics at work in Iran’s educational system, ideally by employing researchers who are completely familiar with applications of these skills. Finally, it seems that student learning and teaching needs to be changed in such a way that financial mathematics courses are developed in finance and business programs over time. In fact, this research reveals that it is essential to notice adult math education and its integration with application fields in society, especially in the world of banking. Finally, for further research, it is recommended to investigate topics such as “evaluating lower-order mathematical thinking in financial affairs for financial employees and students” and “improving the effect of educational programs for mathematical thinking in financial affairs on learners’ educational progress and employees’ professional progress”.

7. Limitations

One of the limitations of this study is its cross-sectional nature; to account for technological changes and their effects on mathematical thinking skills in the workplace (situational needs), it is necessary to perform longitudinal research. Our time limitation meant we only studied a cross-sectional sample. To outline some potential avenues for further research, it would be of great interest to conduct a study wherein the data from the present study is used as reference data to acquire new information, to aid in the application of longitudinal research.

Appendixes

Appendix 1. Demographic characteristics of participants

Participants	141 people (100 %)
Gender (%)	Woman (31 %), man (69 %)
Position (%)	Manager (45 %), Expert (55 %)
Experience (%)	Less than 5 years (4 %), 5 to 10 years (23 %),10 to 15 years (39 %), 15 to 20 years (16 %), 20 to 25 years (5 %), More than 25 years (13 %)
Department (%)	Financial affairs (36 %), Branch (22 %), Related financial affairs (42 %)
Degree (%)	Bachelor (23 %), Master (66 %), PHD (11 %)
Field of study (%)	Finance& banking (2 %), Accounting (11 %), Economy (13 %), Management (30 %), Math (7 %), Engineering (34 %), Law (2 %), Other (1 %)

Appendix 2. Questions

Remembering math knowledge in finance	Mental calculations of 4 basic arithmetic operations will help financial employees in the quick and accurate calculation.
	Remembering mathematical knowledge will help financial employees in regulating financial data.
	Remembering mathematical knowledge will help financial employees in resolving bank likely reconciliation.
	Mathematical knowledge provides a logical framework for determining the relationships among financial variables by employees.
	Mathematical knowledge will help financial employees in finding reasonable solutions when encountering financial problems.
Understanding math in finance	Understanding the practical problems in mathematical finance by employees improves to understand the calculations in computing applications (such as Excel, Camfar).
	Understanding practical problems in financial mathematics by employees improves the quality of financial operations.
	Understanding mathematical calculations in finance by financial employees effects on improving communication with customers (by explanation financial computations to customers in the banking system).
	Financial employees better understand relationships among financial indicators through mathematical relationships among variables.
	Understanding mathematical applied problems in financial matters is effective in improving employees' decision-making.
Appling math in finance	Application of mathematics in finance effects on financial calculations for investment plans by financial employees.
	Application of mathematics in finance provides the ability to solve complicated financial problems by financial employees.

	Application of mathematics in finance contributes to the calculations of discounting future prices by financial employees.
	Application of mathematics in finance contributes to reducing operational risk (through reducing the bobble) by financial employees.
	Application of mathematics in finance by finance employees improves monitoring financial information.

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