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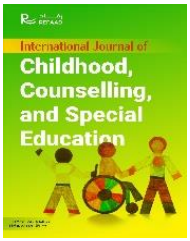

Mathematics Problem-solving in Arabic Children's Picture Books: A Source for Developing Skills and Values

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Research Article

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Abstract:

Objectives: Reading picture books to children has been one of the most engaging activities. However, studies argue that books that include mathematics do not meet the standards required. Additionally, not a lot is known about how problem-solving tasks are presented in these books. Exploring the mathematics problem-solving presentation in Arabic children's picture books in the form of stories is the purpose of this study. The study also seeks to verify to what extent these books follow the standards that enable their benefits.

Methods: Employing the content analysis method, 24 picture books from two series were analyzed; 12 of which are originally written in Arabic and 12 are translated.

Results & Conclusions: Various aspects of children's story plots are uncovered, including posing, representation, solving the problem, and evaluation and interpretations. Most of these features are positive with very few that need to be revised and improved. The study concludes that adult readers' knowledge, expertise, and prior planning for the reading sessions are significant for children to gain the advantages expected and suggests that children's picture books should avoid presenting mathematical content in a didactic approach. In addition, checking the quality of picture books in home and classroom libraries is essential to ensure the best interaction children could have and acquire the advantages they offer.

Keywords: *Children's picture books; Mathematics problem-solving; Early childhood; Early mathematics; Translation of children's books.*

1 Introduction

Children's literature is of specific importance in the early years of life, as its embedded special characteristics respond to children's needs and abilities. One of the most notable features is the presence of pictures and drawings that occupy a large part of it with a small amount of words. That enables children to deal with picture books in accordance with their capabilities and the kind of opportunities adults provide. Exposing children to appropriate book experiences allows them to read the words, enjoy reading pictures and drawings and examine their details while trying to understand them, listen to adults while reading them, or enjoy reading and examining all their components and talking about them with peers or adults, such as the teachers or family members.

Therefore, children's books provide them with opportunities to interact with what they offer and with people, since the content they speculate allows them to face different situations. That is particularly true when reading narrative and story plots compared to informative books (Özdemir, et al., 2019). Furthermore, books may motivate children to ask questions and seek answers, while considering different points of view, sharing perspectives with others, and integrating new with previous knowledge.

This mathematical knowledge and skills have different facets since there are five mathematics content standards, which are number and operations, algebra, geometry, measurements, and statistics and probability, that are outlined by the standards published in different countries. However, the mathematics children learn is not limited to these contents but includes the mathematical processes that describe the different methods used by learners to acquire, understand, and use content. They play an important role in developing mathematical knowledge and understanding since they are considered mental progressions and habits that must be integrated into education to promote thinking that leads to efficiency in mathematics. They include five processes, which are problem-solving, reasoning and proof, communication, connections, and representations (NCTM, 2000).

These processes are highlighted in a different terminology by The National Research Council in the USA through a specific term, which is Mathematical Proficiency. It consists of five intertwined and interrelated dimensions that are conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (Kilpatrick, Swafford, & Findell, 2001). These dimensions represent a more in-depth and practical understanding of what mathematics education means, by achieving long-term goals that prepare learners with the skills needed for life and work rather than the skills needed to succeed in school. Therefore, different countries have adopted these dimensions in mathematics education, such as Saudi Arabia which included the five dimensions in its mathematics standards (Education and Training Evaluation Commission, 2019), as well as Australia, which adopted fluency, problem-solving, reasoning, and understanding in its curriculum (ACARA, 2013). The UK mathematics curriculum emphasizes fluency, problem-solving, and reasoning (DfE, 2013), while the framework of mathematics in Singapore made problem-solving the middle and most important skill between concepts, processes, metacognition, and attitudes (Groves, 2012).

It is worth stating that problem-solving is described in different terms in the abovementioned processes. In the NCTM (2000) standards, the problem-solving process is defined as building new mathematical knowledge through mathematical thinking while applying a variety of appropriate strategies. The reasoning and proof process is described as the use of logic and reasoning as tools to investigate mathematical solutions or information using mathematical arguments, estimation, or intuition, and to select and use different types of reasoning and methods of proof. In the dimensions of mathematical proficiency, strategic competence requires understanding the context of the problem, formulating, and representing it using its elements to solve it, which requires knowing a variety of solution strategies as well as the ability to identify appropriate strategies to solve a particular problem. Adaptive Reasoning means the ability to understand the relationships between given information, related concepts, and situations, and to reason, reflect, and interpret them, by putting all alternatives into consideration, in addition to the ability to justify conclusions and conflicts through employing mathematical thinking and using series of logical steps (Kilpatrick, Swafford, & Findell, 2001).

Considering this complicated nature of mathematics that contains a lot of abstract knowledge and processes, which may be difficult for children to understand and practice, picture books create a means for presenting it in a visual

form within a meaningful, attractive, and interesting context. Therefore, picture books could be used as a resource for education, and their benefits to children depend on the adults' expertise in the features of the books, and how to use them to expand children's understanding of the mathematical content in them (Björklund & Palmér, 2020; Gosen et al., 2015; McMullen et al., 2019). For example, counting pictures of items in books differs from counting real tangible things, where in counting real things, children can move them to be certain of the number, while moving items cannot be done when counting drawings or pictures in books. Thus, other techniques must be learned and used, such as counting systematically from one side to another or covering the numbered elements to be certain that they are all counted without repetition (Dacey & Eston, 1999).

Despite the importance of the adult readers' expertise in using children's books to improve mathematical knowledge and skills, studies showed that children's talk becomes math-centered when they listen to picture books with mathematical content, even if the reader doesn't explicitly explain or hint directly towards mathematics (van den Heuvel-Panhuizen & van den Boogaard, 2008). In line with this, Berkowitz et al. (2015) and McAndrew et al. (2017) found that the positive effects of reading picture books that include mathematics content and skills occur either if the adult readers were teachers or parents. Sonnenschein and Dowling's (2019) review study confirmed that reading mathematics story plots, either with teachers or parents leads to a positive impact on mathematics engagement. Fortunately, most teachers encourage using classroom libraries in mathematics education (Stites et al., 2021). Yet, Arici (2023) found that parents' educational level was a significant determinant of their children's book selection criteria, for the benefits of higher levels of education.

Furthermore, Zhang et al. (2023) found that even math-unrelated reading improves children's mathematical performance significantly, which supports the functional impact of language development on mathematics. That result was explained by the effect of literature on vocabulary improvement and reading comprehension as an essential medium for communicating mathematical information and solving problems, besides practicing reasoning and logical thinking skills while reading through questioning, comparing, categorizing, and predicting. That result is confirmed by Wee et al. (2019) study, which found that the critical literacy approach supported children's critical and logical thinking skills and made meanings by perceiving different/multiple perspectives and challenging stereotypes.

Accordingly, it can be expected that reading picture books with mathematical content has positive impacts on children's performance in mathematics tasks, as they enable them to connect multiple previous and new experiences included in the context of the story in meaningful learning, where they can ask questions and discuss content during dialogue with peers and adults. In addition, reading children's books gradually develops deep understanding and promotes mathematical thinking, as they constitute an excellent mediator between informal and formal mathematics. Therefore, researchers emphasize that reading picture books should not be limited to preschool but must continue to be used in the primary grades, especially since it constitutes an appropriate mediator to arouse discussions and questions and to stimulate thinking that leads to deep understanding and develop problem-solving ability (Al-Bool , 2011; Al-Sharif, 2009; van den Heuvel-Panhuizen et al., 2009; Van den Heuvel-Panhuizen et al., 2016).

In addition, using literature to present mathematics content and problems improves engagement and maintains children's involvement in the tasks. Erol et al. (2023) study showed that engineering design process-based STEAM activities presented with tales improved children's creativity and problem-solving skills, which require extended periods to maintain. Russo et al. (2021) found that using literature to engage students in mathematics lessons was highly enjoyable and mathematically challenging, yet, making tasks clearer and accessible, which supported students' autonomy. The study also extended the definitions of narratives to include other mediums such as movie clips and short films and encouraged educators and researchers to consider them in mathematics education. AbdelSamie et al. (2016) added using educational games besides picture books and reached significant improvements in children's number sense skills. Al-Sayed (2017) moved towards using digital books and found positive developments in children's abilities to use mathematical concepts to produce creative ideas. Other studies added that reading children's books with mathematics content develops positive attitudes toward mathematics learning besides knowledge and understanding (Marston, 2014; McAndrew et al., 2017).

Gosen et al. (2015) remarkable study about children's engagement in solving problems

presented during picture book reading revealed that they interact with the problem spontaneously without the teacher explicitly asking them to do so. The storyline works as a means for children to recognize the context and understand the problematic situation. What creates engaging and interesting circumstances is the implicit indirect nature of the problem within the socio-emotional context of the storyline, where children have the chance to discuss the problem they noticed, which keeps their attention and perception. The narration creates room for a secure atmosphere and allows for critical manipulation of ideas and alternative solutions and possibilities without being under pressure to reach the best decision. Gosen et al. (2015) explain that this leads to two comparable problem-solving interactions; one is by the teacher and children, and the other is by the book characters, which provide opportunities for assessment, logical and critical thinking, and for building confidence and constructive attitudes.

It is worth mentioning the crucial role of values within mathematics education, which can be described in two categories. The first is the embedded values within the context of the problems posed, including justice while making decisions and solving conflicts based on social values vs economic rules. The second category of values are the ones that guide students through their learning journey and support them in maintaining engagement and commitment. Those values span across all subjects but are considered crucial explicitly in mathematics learning bearing in mind its complicated nature, especially while presenting children to problem-solving tasks. This category varies to include different values such as responsibility, perseverance, collaboration, and autonomy (Hattori et al., 2021; Seah et al., 2021). These two categories of values cannot be transmitted without discussion, social dialogue, and interaction between children and adults, including teachers, parents, and even grandparents, who became and have always been taking roles in their grandchildren's care especially when their parents are busy. That raises the significance of social situations in education, where different points of view are perceived and multiple perspectives are challenged allowing for critical and logical thinking skills to flourish, as valuable tools for understanding why things happen and how to deal with them (Wee et al., 2019).

These positive effects on learning, thinking, problem-solving skills, and attitudes highlight the importance of integrating reading children's picture books with mathematics content into daily activities either in school or at home. Nonetheless, studies that worked on analyzing the mathematical content in picture books revealed that books vary in the ways and levels of presentation of mathematical concepts and skills. Yet, most of these studies argue that those books do not meet the standards in terms of the content and skills presented and recommend reviewing and developing them in different aspects (Nurenberger-Haag, 2017; Powell & Nurnberger-Haag, 2015; Splinter et al., 2023; Ward et al., 2017; Yilmaz Genc et al., 2017). In relation to critical thinking skills that support problem-solving, Ersan & Er (2021) state that they are limited to inference, evaluation, and self-regulation in the picture books they analyzed, while higher-level skills such as analysis and interpretation are rather limited and presented directly using a didactic approach.

Accordingly, studying the benefits of reading children's picture books in developing mathematics problem-solving skills and looking at the educational strategies to use them should be based on reliable information about how these skills are presented, as a key aspect that must be initially examined. Bearing in mind that most previous studies have concentrated on investigating mathematics content and skills, without special attention to problem-solving, exploring the mathematics problem-solving presentation in Arabic children's picture books in the form of stories constitutes an initial step to start before studying their use by children and adults as educational tools. Therefore, the study seeks to verify to what extent these books follow the standards that enable their benefits, by answering the following question:

How mathematics problem-solving skills are presented in Arabic children's picture books?

2 Materials and Methods

The study employs the content analysis method using a content analysis form developed by the researcher. The analysis unit was the subject, where the content of the problem presented in the story plot was analyzed according to the form's items, indicators, and elements of analysis.

2.1 Study Tool

The content analysis form is built according to different standards that describe problem-solving aspects in detail. The resources used to build the form included:

- Mathematical Processes described by the National Council of Teachers of Mathematics (NCTM, 2000). Two processes, which

concentrate on problem-solving skills, naming problem-solving, reasoning and proof were in the scope of the study.

- Mathematical Proficiency Dimensions published by The National Research Council (Kilpatrick, Swafford, & Findell, 2001). Two dimensions, which concentrate on problem-solving skills, naming strategic competence and adaptive reasoning were in the scope of the study.
- Mathematical processes in the framework of mathematics learning standards in Saudi schools (Education and Training Evaluation Commission, 2019), which include three processes related to solving problems, which are mathematical problem-solving, modeling and applications, and mathematical reasoning.

The tool, which is the content analysis form, consists of four main items, which are: posing the problem, representation of the problem, solving the problem, and evaluation and interpretations. Each item includes between 4-7 indicators, where each indicator is divided into 2-5 elements of analysis depending on its content, with a total of 22 elements of analysis for the whole form. The content analysis form will be shown in detail in the results section.

The validity of the content analysis form was checked by five referees, concentrating on the links between indicators and elements of analysis, and the accuracy of their descriptions. Their suggestions included making sentences shorter and checking and excluding duplicates between some elements of analysis. The form was refined according to the referees' feedback. The reliability of the analysis across time was verified through an intra-rater reliability check, where the researcher reanalyzed five books after two weeks from the initial analysis. The reliability coefficient between the two rounds was 0.95, which indicates that the tool is reliable and appropriate for the study (Miles & Huberman, 1994).

2.2 Study Sample

Since the study concentrates on mathematics problem-solving tasks in children's picture books, the sample ought to be from books that are meant to present mathematics. Therefore, the researcher searched for series of mathematics picture books in the form of stories. To reach most of the available series, the search was in electronic bookshops since they contain most of the children's books available, including descriptions of the book's content and the targeted audience. There were some series with a small number of books such as 6, and some concentrated on one mathematical content such as numbers or geometrical shapes, therefore they were not suitable for the purpose of the study. The criteria of the sample were a series of stories that include different mathematics content standards, targeted to children 3-8 years old, with a larger number of books.

Therefore, the sample of the study consisted of two series. The first is an original Arabic picture book series that contains 12 story plots, which encompass problem-solving tasks in different mathematics contents that children learn in preschool and first grade. The second one is a translated picture book series, from the original Korean text, that contains 25 books with different mathematics contents. This series is part of a translation project held by Abu Dhabi Authority for Culture and Heritage "Kalima", which aimed for cultural exchange by translation of distinguished work. One of the books in the series was excluded because it was an informative book about the history of numbers. Twelve more books were excluded because they did not include problem-solving tasks, where the stories' plot presented mathematical content knowledge such as writing numbers, counting, ordinal numbers, time passing, positional words…etc. Therefore, the analyzed story plots from this series were 12. The total number of the analyzed picture books in the sample was 24; twelve of which were originally written in Arabic and twelve were translated.

3 Results and Discussion

3.1 Posing the Problem

Table 1 shows the frequencies and percentages of each element of analysis for the first main item: posing the problem.

In the first main item, which is posing the problem, the analysis of the first indicator showed that most story plots raised mathematical problems as the basis of the context, where the plot cannot be comprehended without understanding the mathematical problem content (58.33% of the original Arabic series, 75% of the translated series, and 66.67% of total of both series).The problem was part of the context, where the context and events can be comprehended without understanding the mathematical problem, however, mathematics is still clear in context, in (25%) of all the series and the total of both. The problem appeared incidentally in the plot, where the context and events can be comprehended without understanding the mathematical problem, since mathematics is implicit in context, in only (16.67%) of the original

Arabic series, and none of the translated series. That shows the deliberate features of these story plots in presenting problem-solving on purpose, following the recommendations of various national and international organizations that emphasize this significant skill for learning (ACARA, 2013; DfE, 2013; Education and Training Evaluation Commission, 2019; Kilpatrick, Swafford, & Findell, 2001; NCTM, 2000).

For the second indicator, which is about presenting the mathematical problem in a rational context, the analysis showed that more real-life situations in (75%) of the original Arabic series, compared to more children's interests that include imagination or play in (83.33%) of the translated series, while embracing real-life situations in (50%) of the translated series, where some story plots included both. For example, one story plot presented a problem of real-life bread baking ingredients' measurements from a magic backing book that was provided by a kind baking witch. Another book presented an angry kid who was planning to leave home but was faced with the problem of making decisions on what favorite toys to take according to their sizes compared to the bag he could handle. However, (25%) of the translated series included unsuitable cultural aspects for Islamic content such as magic, witchcraft, and monsters.

Table 1: Posing the problem elements' frequencies and percentages

Indicators: Expresses whether the book:	Elements of analysis	Series1: Original Arabic (n=12)		Series2: Translated (n=12)		Total of both series (n=24)	
		Freq.	%	Freq.	%	Freq.	%
1.1 Raises the mathematical problem as:	– the basis of the context.	7	58.33	9	75	16	66.67
	– or part of the context.	3	25	3	25	6	25
	– or incidental in the context.	2	16.67	0	0	2	8.33
1.2 Presents the mathematical problem in a rational context related to:	– real-life situations.	9	75	6	50	15	62.50
	– or/and children's interests.	3	25	10	83.33	13	54.17
	– includes unsuitable cultural aspects.	0	0	3	25	3	12.50
1.3 Contains	– accurate and error-free mathematical knowledge.	11	91.67	12	100	23	95.83
	– mistakes and errors.	1	8.33	0	0	1	4.17
1.4 Repeats the mathematical problem in:	– a typical way.	7	58.33	2	16.67	9	37.50
	– or different ways.	5	41.67	10	83.33	15	62.50
	– or it does not repeat it.	0	0	0	0	0	0
1.5 Includes:	– one mathematical idea.	7	58.33	5	41.67	12	50
	– or more than one mathematical idea.	5	41.67	7	58.33	12	50
1.6 Presents the data of the mathematical problem in:	– an organized and understandable way.	10	83.33	10	83.33	20	83.33
	– or an unorganized and uncomprehensive way.	2	16.67	2	16.67	4	16.67
1.7 Encourages analysis of the mathematical situation and understanding of the relationships within the event by presenting the problem:	– Indirectly.	9	75.00	12	100	21	87.50
	– or directly.	3	25	0	0	3	12.50

Fortunately, most of the story plots included accurate mathematical knowledge (91.67% of the original Arabic series, 100% of the translated series, and 95.83% of the total of both series). The error appeared in one original Arabic story plot about the functions of three-dimensional geometrical shapes according to their properties. Additionally, one story plot in the translated series was about combining two- and three-dimensional shapes to form new shapes. Although the knowledge and the problem presented were error-free, the situation and drawings were complicated and presented without explanation, which could lead to misunderstanding if not explained and elaborated

properly by adults. This confirms what previous studies have found about the occurrence of most mistakes in children's picture books that involve geometrical shapes (Flevares & Schiff, 2014; Nurenberger-Haag, 2017). It is expected that experienced adults with good knowledge of mathematics often notice these errors and turn them into educational opportunities for children. However, adults who are less experienced and non-specialized in mathematics may not notice these errors and therefore go uncorrected, which may lead to the development of false mathematical knowledge (Trakulphadetkrai et al., 2019). This emphasizes the need to evaluate books and ensure their quality and content before presenting them to children, to identify faults and errors either to turn them into good learning opportunities or to exclude them if that is not possible.

Although all the story plots repeated the problem in the plot to ensure children's grasp of the concepts and relations involved, the original Arabic series used more typical ways (58.33%) than various ways (41.67%), compared to the translated series that relied more on different ways to repeat the problem (83.33%). Repeating a problem in a typical way is meant to be in one way without variation (e.g. adding the same type of things, classification based on one property such as color, or simple patterns...), while repeating a problem in different ways means variation in repetition (e.g. counting arranged and scattered things, dividing a number into two and three parts, dividing one pizza into fractions of half and quarter, different types of patterns...), which elevates understanding and making mathematical relations. The same for including one or more than one mathematical idea in the problem, the original Arabic series included one mathematical idea (58.33%) more frequently than more than one (41.67%), compared to the translated series, which was the opposite, where including more than one mathematical idea was more frequent (58.33%) than including one (41.67%). When the problem involves a single mathematical skill or procedure (e.g. comparing lengths, counting, addition, subtraction, classification...), it is much easier than when it involves more than one skill or procedure (e.g. classification and pattern, comparison of length, weight and volume, counting by ones and tens...). Yet, the two percentages were close with no big difference, and both are needed, one and more than one mathematical idea depending on the plot of the story, but children's age and abilities must be considered when presenting such content. However, repeating the problem in various ways is beneficial for understanding concepts and relations.

Considering the presentation of the mathematical problem's data, most story plots in both series used organized and understandable methods (83.33%), which is a good indicator. Only two stories from each series failed to present data clearly. This might be related to the complicated concepts they involved that need concrete sensory manipulation, which are measurements, and geometrical shapes, in addition to one abstract concept, which is calculating age by months. Such variation in concepts, relations, methods of presentations, and repetitions supports understanding and expands children's abilities to realize various aspects to reach solutions. However, getting the benefits of such methods depends on the adults' knowledge and proficiency in using the features of the books (AbdelSamie et al., 2016; Al-Sayed, 2017; Björklund & Palmér, 2020; Dacey & Eston, 1999; Gosen et al., 2015; McMullen et al., 2019).

Encouraging analysis of the mathematical situations and understanding the relationships within require presenting the problem indirectly or directly. Marston (2016) noted that many researchers and authors have criticized books in which mathematical knowledge is clear and explicit. Hellwig et al. (2000) explained that the direct presentation of math content in children's books does not provide an opportunity to think about solving problems and does not provide meaningful and engaging experiences. Nesmith & Cooper (2010) added that it may have negative effects on children if they are solely written for education, directly guiding children towards learning mathematics, whereas other aspects such as fun, illustration, and other characteristics of children's picture books are neglected. Such types of books may make children lose their interest in reading besides mathematics. In contrast, the implicit indirect nature of the problem within the social context of the storyline creates engaging and interesting circumstances, where children discuss the problem keeping their attention and perception. That secure atmosphere allows for critical manipulation of ideas and alternative solutions without being under pressure to reach the best decision (Gosen et al., 2015). Most of the analyzed story plots in both series presented the problem indirectly (75% of the original Arabic, 100% of the translated series, and 87.50% of the whole sample).

3.2 Representation of the Problem

Table 2 shows the frequencies and percentages of each element of analysis for the second main item: representation of the problem.

In the second main item, which is the representation of the problem, stimulating interaction with the mathematical problem to represent it was shown in different levels. The highest was in the translated series for repetitive events or actions that facilitate prediction (91.67%), followed by conflicts, ambiguities, or errors (75%), while the lowest was for sudden or humorous events (5%). For the original Arabic series, similar percentages of asking questions, conflicts, ambiguities or errors, and sudden or humorous events (50%, 41.67%, 41.67% respectively), with no repetitive events or actions that facilitate prediction, in contrast with the translated series. In the total of both series, similar percentages for the four simulation methods are shown (41.67%, 58.33%, 45.83%, 45.83%). All are good, yet repetitive events that facilitate prediction are considered good stimulation in children's books since they support understanding relations and making representations that lead to solutions. Gosen et al. (2015) explained that the storyline that enables children to recognize the context and understand the problematic situation within an implicit indirect plot keeps them engaged and attended. Therefore, skills such as interpretation, prediction, reasoning, and logical thinking can be developed through a critical literacy approach that supports making meanings and perceiving and challenging different perspectives (Al-Sayed, 2017; Wee et al., 2019).

Table 2: Representation of the problem elements' frequencies and percentages

Indicators: Expresses whether the book:	Elements of analysis	Series1: Original Arabic (n=12)		Series2: Translated (n=12)		Total of both series (n=24)	
		Freq.	%	Freq.	%	Freq.	%
2.1 Stimulates interaction with the mathematical problem to represent and model it by:	– asking questions.	6	50	4	33.33	10	41.67
	– or/and conflicts, ambiguities, or errors.	5	41.67	9	75	14	58.33
	– or/and sudden or humorous events.	5	41.67	6	5	11	45.83
	– or/and repetitive events or actions that facilitate prediction.	0	0	11	91.67	11	45.83
2.2 Encourages the representation and modeling of mathematical problems in one or more than one way including:	– sensorial.	9	75	12	100	21	87.50
	– or/and iconic.	9	75	11	91.67	20	83.33
	– or/and symbolic.	3	25	3	25	6	25
	– does not encourage representation and modeling.	2	16.67	0	0	2	8.33
2.3 Shows the mathematical problem in the drawing to:	– represent what is included in the text.	10	83.33	12	100	22	91.67
	– or/and clarify what is not included in the text.	0	0	5	41.67	5	20.83
	– the drawings do not include mathematical representations.	2	16.67	0	0	2	8.33
2.4 Draws attention to the important mathematical data or terminology for modeling the mathematical problem by:	– color, lines, or arrows… distinctions.	2	16.67	9	75.00	11	45.83
	– or/and mathematical representations (symbols, equations...)	2	16.67	4	33.33	6	25
	– or/and additional practice activities by the end of the book.	0	0	12	100	12	50
	– or/and tools accompanying the book.	0	0	0	0	0	0
	– or does not draw attention to the important mathematical data or terminology for modeling.	9	75	0	0	9	37.50
2.5 Discusses ways to represent and model the mathematical problem by:	– providing explanations about ways and reasons for representations.	4	33.33	11	91.67	15	62.50
	– or does not discuss ways and reasons for representations.	8	66.67	1	8.33	9	37.50

Bruner suggests that children interact with representations of knowledge in three levels: enactive/sensorial, iconic, and symbolic. When children go through these experiences, within the plot of stories that represent knowledge in real-life and imaginative situations, they develop contextual meanings, which make them reasonable and functional. Therefore, including mathematics representations in the story plots within these three levels supports children's learning. Sensorial experiences require direct interaction with materials and tools, which is not possible while reading books, but the characters' interactions with materials demonstrate sensorial experiences and encourage children to imitate them. Images and drawings of things manipulated, and symbols that represent them are very much possible on books' pages. The sensorial and iconic mathematical representations are clearly shown in both original Arabic (75%, 75% respectively) and translated books (100%, 91.67% respectively), while symbols are less shown (25%) in both series, which is compatible with children's age. Very few (16.67%) of the original Arabic books do not include any level of representations that encourage modeling, which makes it difficult to understand without the adults' support to model the situation.

Considering the relation between text and drawings, (83.33%) of the original Arabic, and (100%) of the translated books represent what is included in the text, while (41.67%) of the translated books added drawings that clarify extra information not included in the text. For example, in two story plots about patterns, the pages included representations of patterns that were not mentioned in the text, and some of them included mistakes. The same with a story plot about comparing measurements, the drawings represented units that were not mentioned in the text. In another two story plots, one about counting and the other about part-whole numbers, the pages included drawings of things that are not mentioned in the text to count and split into parts. These are wonderful opportunities for adult readers to deliberate on and to allow for practice and discussions with peers. On the other hand, drawing attention to the important mathematical data or terminology for modeling the mathematical problem was less used in the original Arabic series compared to the translated, which was through using color, lines, or arrows… (16.67%, 75% respectively), mathematical representations such as symbols, equations... (16.67%, 33.33% respectively), and additional practice activities by the end of the book (0%, 100% respectively). Moreover, (75%) of the original Arabic books did not use any method to draw attention to the important mathematical data for modeling. Discussing ways to represent and model the mathematical problem within the plot of the story was also less used in the original Arabic series compared to the translated (33.33%, 91.67% respectively).

Although noticing and using these opportunities greatly depends on the adults' expertise to utilize these features (Björklund & Palmér, 2020; Gosen et al., 2015; McMullen et al., 2019), still, they could be considered chances that might drag children's attention. Studies showed that children notice mathematical content even if the adult reader does not explain or hint at it directly (van den Heuvel-Panhuizen & van den Boogaard, 2008). Gosen et al. (2015) study confirms that children interact with problematic situation spontaneously without adult readers' request because they recognize it within the storyline. Moreover, the positive impact on mathematics learning occurs even if the adult readers are teachers or less experienced adults such as parents (Berkowitz et al., 2015; McAndrew et al., 2017; Sonnenschein & Dowling, 2019).

3.3 Solving the Problem

Table 3 shows the frequencies and percentages of each element of analysis for the third main item: Solving the problem.

In the third main item, which is solving the problem, stimulating thinking about a strategy to solve the mathematical problem by questions, conflicts, or repetitive patterns... and giving chances to stop and think was less shown in the original Arabic compared to the translated books (50%, 100% respectively). The same goes for linking previous experiences to facilitate selecting a method for solving the mathematical problem, where the translated books (100%) outperformed the original Arabic (41.67%) with a considerable difference. Drawing attention to the available alternatives to solve the mathematical problem by discussing and proposing more than one way to solve the problem was also more frequent in the translated picture books (75%) compared to the original Arabic books (50%). Using intuition or estimation for solving problems as prompts for thinking and attempts to manipulate concepts and relations was also less shown in the original Arabic compared to the translated books (16.67%, 75% respectively). Guiding towards solutions that use mathematical methods based on solid knowledge has been shown in high similar percentages for the two series (83.33%, 100%). By the end of the story

plot, presenting one or more than one specific way to solve the mathematical problem has been shown in similar percentages for each method in the two series, which resulted in (50%) of the total of both series for each method.

Table 3: Solving the problem elements' frequencies and percentages

Indicators: Expresses whether the book:	Elements of analysis	Series1: Original Arabic (n=12)		Series2: Translated (n=12)		Total of both series (n=24)	
		Freq.	%	Freq.	%	Freq.	%
3.1 Stimulates thinking about a strategy to solve the mathematical problem by:	– questions, conflicts, or repetitive patterns... and gives a chance to stop and think.	6	50	12	100	18	75
	– or provides solutions directly.	6	50	0	0	6	25
3.2 Links with previous experiences that can facilitate selecting a method for solving the mathematical problem	– such as using counting skills or subitizing to solve addition problems, observing the external properties to make a pattern, and recognizing the properties of three-dimensional shapes to choose the appropriate ones for a specific task such as cylindrical for directed movement.	5	41.67	12	100	17	70.83
	– or does not link with previous experiences that can facilitate choosing a solution method.	7	58.33	0	0	7	29.17
3.3 Draws attention to the available alternatives to solve the mathematical problem by:	– discussing and proposing more than one way to solve the problem.	6	50	9	75	15	62.50
	– or provides one way for a solution.	6	50	3	25	9	37.50
3.4 Uses intuition or estimation	– as an acceptable attempt or method for solving the problem and may be justified or criticized.	2	16.67	9	75	11	45.83
	– or does not use estimation or intuition to solve the problem.	10	83.33	3	25	13	54.17
3.5 Guides towards solutions	– that use mathematical methods based on mathematical knowledge.	10	83.33	12	100	22	91.67
	– or does not guide towards solutions that apply mathematical knowledge either using intuition or leaving the problem unsolved.	2	16.67	0	0	2	8.33
3.6 Presents (by the end of the story)	– one specific way to solve the mathematical problem.	7	58.33	5	41.67	12	50
	– or more than one way to solve the mathematical problem.	5	41.67	7	58.33	12	50

In support of these methods that stimulate reasoning and manipulation of ideas, it is found that provoking children's mathematical thinking through literature is enjoyable, and challenging, and maintains their interests and autonomy, while improving creativity and problem-solving skills (Al-Sayed, 2017; Erol et al., 2023; Gosen et al., 2015; Russo et al., 2021). Furthermore, these methods develop deep understanding and promote mathematical thinking, since they enable children

to link informal and formal, previous and new knowledge and skills, in meaningful learning within the context of the storyline during dialogue with peers and adults (Al-Bool, 2011; Al-Sharif, 2009; van den Heuvel-Panhuizen et al., 2009; Van den Heuvel-Panhuizen et al., 2016). That certainly supports developing positive attitudes toward mathematics learning besides understanding and problem-solving skills (Marston, 2014; McAndrew et al., 2017).

3.4 Evaluation and Interpretations

Table (4) shows the frequencies and percentage of each element of analysis for the fourth main item: Evaluation and interpretations.

The fourth main item, which is evaluation and interpretations, includes verifying the validity of the solution by providing justifications for its results or reasons for its selection, which came in close percentages for both series, with slightly higher percent for the original Arabic story plots compared to the translated (75%, 58.33% respectively), resulting in (66.67%) for the total of both series. Discussing the mathematical relationships and knowledge built was less shown in the original Arabic series compared to the translated, with no big difference (58.33%, 66.67% respectively), resulting in (62.50%) for the total of both series. Using the mathematical problem as an access to new mathematical knowledge was less shown in the original Arabic series compared to the translated (16.67%, 41.67% respectively). These indicators are mainly related to connecting previous to new knowledge and understanding relations (Al-Bool, 2011; Al-Sharif, 2009; Gosen et al., 2015; van den Heuvel-Panhuizen et al., 2009; Van den Heuvel-Panhuizen et al., 2016). Therefore, they should appear at least at moderate levels, to the extent that the story plot allows in order not to ruin it and make the mathematical content presented directly using a didactic approach (Ersan & Er, 2021; Gosen et al., 2015; Splinter et al., 2023; Ward et al., 2017).

Table (4): Evaluation and interpretations elements' frequencies and percentages

Indicators: Expresses whether the book:	Elements of analysis	Series1: Original Arabic (n=12)		Series2: Translated (n=12)		Total of both series (n=24)	
		Freq.	%	Freq.	%	Freq.	%
4.1 Evaluates, comments, and/or justifies the solution of the mathematical problem by:	– verifying the validity of the solution, providing justifications to confirm its validity, or reasons for using the solution method.	9	75	7	58.33	16	66.67
	– or does not evaluate, comment, or justify the solution or methods used.	3	25	5	41.67	8	33.33
4.2 Encourages explanation by:	– discussing the mathematical relationships and the knowledge built.	7	58.33	8	66.67	15	62.50
	– or does not encourage an explanation of the mathematical relationships and knowledge built.	5	41.67	4	33.33	9	37.50
4.3 Uses the mathematical problem	– as an access to new mathematical knowledge.	2	16.67	5	41.67	7	29.17
	– or does not use the mathematical problem as an access to new mathematical knowledge.	10	83.33	7	58.33	17	70.83
4.4 Draws attention to the values within the problem-solving task	– such as Justice, honesty, positive relationships, and cooperation… by referring, discussing, and confirming them.	10	83.33	11	91.67	21	87.50
	– or does not draw attention to the values within the problem-solving task.	0	0	0	0	0	0
	– or there are no clear values in the mathematical problem that can be referred to or discussed.	2	16.67	1	8.33	3	12.50
	– or/and the problem involves some negative behaviors such as theft, cheating, deception...	6	50	9	75	15	62.50

Regarding the values in children's picture books that include mathematics, both series have drawn attention to the values within the problem-solving task such as justice, honesty, positive relationships, and cooperation… by referring to, discussing, and confirming them. The values were explained through understanding the mathematical content, such as justice in the division, cooperation in arranging things by tens or fives and returning the same amount of money lost. The values appeared with no big difference between the original Arabic and the translated series (83.33%, 91.67% respectively), resulting in (87.50%) for the total of both series, and none of the story plots neglected values existing in the plot. Very few story plots did not include clear values in the mathematical problem that can be referred to or discussed (12.50% of the total of both series). The problems presented involve some negative behaviors such as theft, cheating, and deception..., but that was less shown in the original Arabic series compared to the translated (50%, 75% respectively), resulting in (62.50%) for the total of both series.

The values included in the story plots were embedded within the context of the problem, and mathematics is used to solve conflicts and make reasonable, fair, and kind decisions. Most of the negative behaviors were used to demonstrate how conflicts and problems can be solved by utilizing mathematics knowledge and skills. However, these values cannot be passed and absorbed without social interaction and dialogue between children and adults (Hattori et al., 2021; Seah et al., 2021), including teachers, parents, and grandparents.

4 Conclusions & Recommendations

Throughout this study, various aspects of children's picture books are uncovered. Fortunately, most of them are positive with very few that need to be revised and improved. Since the sample was selected from books that include mathematics problem-solving, their content was purposefully guided towards this objective, while implementing appropriate conduct for most of the features. These features include accurate content, repetition of the problem in different ways, indirect presentation of the problem, and clear presentation of the data needed to understand and solve the problem. However, some weaknesses have appeared more frequently in the original Arabic picture books. Therefore, it is recommended that adults prepare themselves with the knowledge, skills, and materials required before reading books to children.

In helping children represent the problem, repetitive events that facilitate prediction, understanding relations, and making representations that lead to solutions must be more considered in the original Arabic content compared to the translated series. Moreover, purposeful drawings that provide opportunities for questioning, thinking, and practice would facilitate deeper understanding, and attend to the more developed children. The same with drawing attention to the important mathematical data or terminology and discussing ways for modeling the mathematical problem within the plot. Considering developmentally appropriate practices, the picture books included more sensorial and iconic than symbolic representations, and they are extremely important, yet, using them properly requires adults' experience, knowledge, and prior planning.

Regarding the features that support children in solving the problem embedded within the storyline, it appeared that the translated book series provided more proficient examples in this area. Stimulating children's thinking, relating to previous knowledge and skills, drawing attention to the available alternatives, using intuition or estimation, and guiding towards solutions that build on solid mathematical knowledge were all well presented in the translated picture books. By the end of the story plot, presenting one or more than one specific way to solve the mathematical problem was equally shown in both series, since choosing any depends on the mathematical content and the plot.

The indicators of evaluation and interpretations are mainly related to linking previous to new knowledge and understanding relations. Therefore, verifying the validity of solutions, and discussing the mathematical relations and knowledge built have come in moderate levels, in order not to ruin the storyline, avoiding direct didactical presentation of the mathematical content. Using the mathematical problem as access to new mathematical knowledge depends on the mathematical content and the plot that might or might not facilitate it. Including values within the mathematical problem was frequently shown in both series, in addition to some negative behaviors that appeared to demonstrate utilizing mathematics in solving conflicts and problems.

Although the translated books include lots of positive features and establish wonderful and inspirational examples that help improve Arabic children's literature; unfortunately, they encompass some inappropriate cultural aspects

that do not suit children in Islamic and Arabic contexts. Therefore, it is highly recommended that Arabic children's literature benefit from others' experiences in presenting mathematics and problem-solving skills through children's picture books, while considering appropriate cultural aspects. In addition, translation projects are perfect opportunities for rich cross-cultural and experience exchange. Nevertheless, there should be some allowance for making amendments to any inappropriate content. Children are vulnerable to what they interact with, raise questions, and seek answers, which would become difficult when they are presented with undesirable content.

To summarize, the features of children's picture books that include mathematics play an important role in acquiring mathematical knowledge, critical and logical thinking, and problem-solving skills. Adult readers, including teachers, parents, or grandparents, are key persons in getting the benefits of reading those books; since their knowledge, expertise, and former planning for the reading sessions are significant for children to gain the advantages expected. Prior planning for reading sessions appeared to be crucial for checking the suitability and accuracy of the content, overcoming any faults either by turning them into good opportunities for learning or excluding them. Preplanning also facilitates preparing activities or materials needed for practice and better understanding. Nevertheless, if the picture book adhered to the recommended features, it could support children's learning even if the adult reader was less experienced or did not have enough preparation. Therefore, checking the quality of picture books in home and classroom libraries is essential to ensure the best interaction children could have to acquire the advantages they offer.

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