



LET'S READ TOGETHER": A BALANCED COMPUTER ASSISTED INTERVENTION PROGRAM AND ITS EFFECT ON COMPREHENSION AMONGST AT LINGUISTIC RISK ARAB FIRST GRADERS

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ABSTRACT

The current study investigated the effectiveness of an early balanced computer-assisted intervention program in promoting comprehension skills among Arabic-speaking first graders from disadvantaged socio-economic background, when taking into account the interplay between risk factors impacting Arabic reading acquisition: Arabic language complexity, poor literacy skills and the cognitive and emotional challenges when commencing formal schooling. Forty at literacy-risk Arab first graders were randomly assigned to either the intervention or a comparison group, each including 20 children. A qualified tutor was assigned to each participants in the intervention group. To assess the children's progress in the intervention group, measurements were carried across three different periods during the implementation of the program. In addition, comprehension assessments were administrated to both groups prior and after the program commencement and completion, respectively. The intervention group showed greater progress in comprehension skills and vocabulary when compared to the comparison group in all the measurements. The obtained results stress the necessity for early balanced intervention in order to close the gaps in comprehension skills among at-risk children.

Indexing terms/Keywords

Arabic; Literacy risk; comprehension; first grade; vocabulary; motivation; teaching; individual learning; computer assisted intervention; reading skills.

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INTRODUCTION

In the last years, both international and national literacy assessment reports point to the lag in reading literacy achievements of Israeli Arab speakers when compared to their Hebrew-speaking counterparts [1;2]. Accordingly, it has been posited that such discrepancy has been attributed to Arabic Diglossic nature [3]. Israeli Arab low socio-economic status affects emergent literacy skills as well as later reading acquisition [4].

In addition to contextual factors affecting reading acquisition, up-to-date testimonies from the educational field assert that the process of becoming literate is not accomplished in its entirety by all children. The difference among the children indicates a need to develop differential instruction. Consequently, the present study, follows the progress of at-risk children in literacy acquisition during the implementation of a balanced tutoring computer-assisted reading literacy program while attempting to investigate whether the implemented curricular literacy programs in class are sufficient and apt to cope with the deficits exhibited by the children.

The Road to Reading Comprehension: From Reading to Comprehending

Reading acquisition in Arabic

Language Features: The Case of Arabic

Arabic is mainly characterized by its Diglossic nature, which refers to the existing gap between spoken and written Arabic, resulting in two variations of the same language. Accordingly, spoken and literary Arabic differ in Vocabulary, grammar, syntax, morphology, phonology and expression forms [5; 6; 7; 8]. At the early stages, Arabic native speakers learn 'Ammia' or Spoken Arabic (SA- Spoken Arabic) as their first language (L1) where dialect variation is seen across some geographical areas. In contrast, 'Fuṣḥa' (i.e., literary Arabic), more commonly referred to as 'Modern Standard Arabic' (MSA), is used for written communication and in religious, educational and other formal domains. MSA is acquired through formal instruction where it is suggested that it functions as a second language (L2) [5;9]. As a result, Arab children are deprived from adequate exposure to literary Arabic at early stages, affecting the development of the required meta-linguistic, and literacy skills underlying successful reading literacy acquisition and academic performance [10;11;12;13].

Accordingly, Years of research have stressed the vitality of phonemic awareness across languages, noting that struggling readers tend to demonstrate lower levels of phonological skills when compared to skilled readers [14; 15;16]. Thus, it is necessary to take into account the phonological features of the language when starting to teach reading and writing. In Arabic, the phonemic inventory can be classified in terms of a set of phonetic properties or phonemes' inclusion in SA: Fricatives (phonemes that could be pronounced separately), Plosives (could not be pronounced as separate phonemes because of the air exiting in the pronunciation process), Emphatic (phoneme similar to other phonemes but are more magnified) and Diglossic (part of the phonemic inventory of MSA but not SA). In addition to the phonological constraints of Arabic language, its orthographic complexity adds another obstacle for reading and writing acquisition, inducing visual load during visual processing of words, resulting in slower word identification [17; 18; 19] and affecting grapheme-phoneme correspondence. Consequently, comprehending the means by which Arabic orthographic characteristics can significantly contribute to our understanding of reading acquisition and reading difficulties among Arab children.

In Arabic, the shape of the letters change in accordance with their position in a word. For instance, the letter 'ع' appears as 'ع' at the beginning of a word, as 'ع' in a middle of a word and as 'ع' at the end of a word. Furthermore, visual similarity exists between some of the letters where they differ in the number (1, 2 or 3) and the position of dots (e.g. ت, ث, ب). Ultimately, the letters are written cursively from right to left (i.e. عُصْفُورٌ [bird]). Therefore, children have difficulty in detecting where a letter begins and ends.

The orthographic depth of Arabic poses additional challenge for literacy acquisition among Arab children. Orthographic depth is determined by the degree of correspondence between letters (Grapheme) and the sounds (Phonemes) they represent [20]. In Arabic case, the orthographic depth is determined by whether the letters are superimposed by dialectical marks or not. Omission of the dialectical marks (denoting vowel sounds) imposes ambiguity since it reduces the grapheme-phoneme correspondence. Hence, when required to read unvowelized script, missing phonological information needs to be inferred from contextual and lexical cues. Furthermore, one word in Arabic can resemble a whole sentence In English (e.g. رأيتموها, means: you have seen her).

Socio-economic background and literacy development

Socio-economic status (SES) has long been linked to children development in the early years, especially to emergent literacy skills, and to subsequent academic achievements [21; 22; 23]. Already in kindergarten, children from low SES demonstrate low achievements in literacy skills and are thus considered at-risk for developing reading difficulties throughout their school years [24; 25; 26; 27]. Specifically, children from lower SES depict lower phonological awareness, vocabulary knowledge and word recognition and writing [28; 29; 30].

It has been documented that Arab population fall behind Israeli Jewish families in terms of SES due to lower income, parental education, employment opportunities and higher rates of poverty [31]. Interacting with the challenges posed by Arabic diglossic nature, SES is thought to contribute to the discrepancy in reading achievements between Hebrew and Arabic speakers [32].



Reading Comprehension in Arabic

Reading comprehension is an interactive process requiring simultaneous meaning retrieving and construction, incorporating vast area of skills ranging from efficient word decoding to language processing and higher cognitive skills [33; 34; 35]. In addition, the role of strategic practices and world knowledge is seen as a key component in reading comprehension [36; 37; 38; 39; 40].

Reading is the act of decoding orthographic units into their equivalent sound units to ultimately construct meaning [41]. Serious scientific efforts have been exerted in an attempt to identify the features of the reading process. Much attention was drawn to the role of phonological awareness in reading and comprehension [e.g. 42; 43; 44; 45].

Due to Arabic features, collected data suggests that the interactive model for reading acquisition [33] is a suitable cognitive model for acquiring reading in Arabic [46; 47; 48; 49; 50]. According to this model, reading acquisition is a process requiring a parallel activation of four processors: phonology, orthography, semantics and context.

In addition to the complexities of the Arabic phonemic system, it seems that lack of sufficient exposure to literary Arabic due to Arabic's diglossic nature aggravates the difficulties encountered in phonological processing [50;51]. Specifically, since Arabic is a Semitic root-based morphology language, morphology seems to be a very important contributor to the reading process and to deriving meaning [1; 52]. Hence, improving phonological skills and morphological knowledge is essential to enhance reading skills, including reading comprehension.

Overall, fostering contextual and semantic processes might serve to compensate for deficits in reading competence as a result of lower reading fluency, thus aiding in meaning construction [53; 54; 55]). Contextual cues and semantic knowledge contributes to mastery of grapho-phonemic skills, guiding the reader when engaged in decoding, giving him feedback to the quality of his performance and ultimately deriving meaning [56]. Specifically, due to Arabic Diglossic nature, and more limited vocabulary knowledge, the promotion of contextual processing is vital [46].

Educational technology, individual tutoring and literacy

Technology integration for educational uses has escalated in the past few decades, especially for literacy promotion. The incorporation of visual and auditory stimulation in addition to the graphic adjustments that computerized environments can provide has been proven very beneficial in fostering the underlying skills in reading, such as letter- sound correspondence, word decoding and phonological awareness, in part by enhancing children's interest and reading motivation [57; 58 59; 60; 61]. The gain from computer-assisted instruction is enhanced when combined with individual tutoring. Various studies have pointed to the success of computer-assisted individual tutoring programs in enhancing reading decoding skills and reading comprehension [62; 63; 64].

The Context of the Study

The current study draws on previous scientific works dealing with the two risk factors that jeopardize reading acquisition : The Diglossic nature of Arabic and its orthographic depth, and low socio-economic status. The assumption is that instructional approaches (i.e computer- assisted individual tutoring environment) can be useful in devising a balanced intervention program that promotes comprehension skills and vocabulary knowledge, for beginning readers in Arabic.

Accordingly, the purpose of this study is to investigate the efficacy of our program in improving comprehension skills and vocabulary among at-linguistic risk Arab first graders.

The study questions are:

- 1) Will the intervention program be effective in improving comprehension skills and vocabulary knowledge, as measured via different measurement techniques such as immediate story recall, delayed recall, retrieval of information, and inference and interpretation?
- 2) In the intervention group, is there an effect for the intervention program on promoting comprehension skills in the three measurements across different periods during the scholastic year?

METHOD

Participants

Initially, 60 at-linguistic risk native Arabic speaking first graders, attending elementary school located in low SES neighborhood in northern Israel, participated in this study. Comprehension screening tests were administered to all initial participants. Based on the children's reading grades, as reported by their teacher, and their performance on the comprehension screening test, the 40 lowest scoring children were randomly assigned to either the intervention or the comparison group (20 participants in each group). The intervention group was also characterized with respect to level of achievement in the pre-test results and the teachers' reports: struggling readers, novice readers, advanced readers and expert readers.

A qualified personal tutor (third year college students working towards their teaching certificates) was assigned to each child in the intervention group. It is worthy noting that the intervention program was carried out in addition to the received in-class instruction.



The Intervention Program

An interactive computer-assisted tutoring intervention program was designed to promote comprehension skills among at-risk linguistic first graders. It draws on Adam's model [33] addressing the four processors underlying reading acquisition: phonology, orthography, semantics and context. In addition, it seeks to promote decoding skills and fluency, as a bridge to improve reading comprehension and minimize literacy gaps resulting from the discrepancy between spoken and literary Arabic.

The constructed activities in the program and the addressed comprehension skills followed the accepted scientific scheme, for example, based on the works of Snow, Burns and Griffin [26]. Additionally, the program was developed in cooperation with experts in the field of literacy acquisition and following the requirements of Israeli Arabic language curriculum for the Arab sector.

The instructional sessions were administered in a One-to-one computer assisted tutoring environment to insure that the needs of each child are met. Prior to the program's commencement, the selected tutors underwent an extensive training, introducing the contents of the different sessions, activities, and guidelines on how to use the program software. Each tutor received a CD-ROM copy of the software, a guide with full instructions and recording booklet. Additionally, before and during the program, the tutors had weekly briefings, dealing with the difficulties arising during the sessions and the manners of dealing with them.

Intervention procedure

The program consisted of 26 instructional sessions, each lasting 45 minutes, two days a week during Arabic language lessons throughout the scholastic year. The activities in each week were built around a single narrative text which is a close genre to the children's world (an overall of 13 texts were presented), all starting with an introductory conversation, followed by pre-reading activities, reading activities, and post-reading activities, respectively.

At the beginning of the year, the texts were read aloud by the tutors since they were just starting to learn how to read. After acquiring the required reading skills along the program, text readings were independently carried out by the children.

For each session, the tutor documented the child's responses and any incorporated modeling. In addition, the children's responses were registered by the computer and saved on a computer file to allow a daily follow-up on their performance and monitor their progress.

In order to ensure standardized and adequate delivery of the program, the researcher, accompanied by a professional teacher, carried observational sessions. The tutors were evaluated for their capacity to correctly implement the lesson plan.

Testing procedure

To assess the initial level of all children, a comprehension-screening test was administered to all 60 children. After the program termination, similar comprehension screening test was administered to both intervention and comparison group.

In the intervention group, another three intermediate measurements were held during the intervention program implementation, in order to follow the children's progress in comprehension skills:

- First measurement (M1) was held after the completion of the first six sessions (i.e. after dealing with the first three stories)
- Second measurement (M2) was held to evaluate the children competencies on the learned themes for stories six-eight (sessions 11-16).
- Third measurement (M3) was held at the end of the program implementation, addressing the learned stories 11-13 in sessions 21-26.

For each measurement, evaluating the children on three learned stories, an overall rating percentage was calculated for each of the assessed categories and comprehension indexes.

Measures

For data collection, the following measures were used:

- 1) Pre-post comprehension screening test: two tests were administered, for screening and progress evaluation purposes in order to compare between the intervention and comparison groups, before and after intervention. The tests were designed following the Israeli Arabic language curriculum requirements [65], incorporating the following components: Immediate story recall, explicit information retrieval, event sequencing, inference, main idea, cause and effect relationship, analysis and synthesis, vocabulary and instruction comprehension. For each incorrect response, the tutor asked the child to choose the correct answer out of two presented alternatives. In this case, correct response granted him half of the designated score for each question.
- 2) Three Intermediate measurements of comprehension skills: in each measurement, the children's performances in comprehension skills were evaluated by the after mentioned tests:



- Immediate and delayed story recall task:

on each intermediate measurement, the children were assessed by an immediate (in the same session) and delayed (in the successive session dealing with the same story) story recall task, after being read to them by the tutor. The scoring guide is provided in Table 1.

Table 1. Immediate and delayed story recall scoring and evaluation criteria [46]

	1	2	3	4
scoring	Struggling	Novice	advanced	Expert
Evaluation criteria				
<ul style="list-style-type: none"> ▪ Recalling main details and events. Usage of a story schema (background details, characters, time and place, conflict and solution) 	Incorrect recall of the story's events or abstaining from responding.	Recalling words appearing in the text and incorrect events' sequencing.	Partial recall of the story events and details while maintaining a partial sequencing of events.	Recalling main details and events, ... Usage of a story schema and maintaining logical and adequate sequencing of events.
<ul style="list-style-type: none"> ▪ Sequencing 				

- Reading comprehension evaluation task: the measure included a set of questions dealing with the presented test on the assessment session, addressing the different components of reading comprehension skills as proposed by PIRLS (Progress in Reading Literacy Study) theoretical framework [32; 66;67]. The questions incorporated explicit information retrieval, straight forward inference and interpretation and integration of ideas. (Scoring guide and sample questions are provided in Table 2). Examination and estimation of language, textual and contextual elements were not included since it is not part of their curriculum requirements.

Table 2. Reading comprehension scoring guide

	1	2	3	4
comprehension skills	Struggling	Novice	advance d	Expert
1. Explicit information retrieval.	Incorrect answer/ abstaining from answering (after verifying that the child has fully understood the questions and requirements).	Partial concise answer that contains incorrect details.	Partial response including only correct details.	Complete correct answer.
2. Inference:				
2.1 Making straight forward inference;				
2.2 Interpretation and interpretation of ideas.				

On both tests, each child received a score ranging from one to four (one= struggling, two = novice, three= advance and four= expert) following his performance on the different evaluation criteria (See Table 1 and 2).

Data Analysis

A comprehensive evaluation of the program was conducted via collection and analysis of both quantitative and qualitative data, accompanied by close follow-up of the children's progress throughout the program.



To answer the first study question, Wilcoxon Signed-ranks test was conducted for the intervention and comparison group, comparing the children's overall scores on the pre and post reading comprehension test. In addition, to evaluate pre-treatment and post-treatment differences in reading comprehension between the intervention and comparison group, Mann-Whitney tests were calculated.

In order to answer the second question, an average rating percentage was calculated, composed of children's performance ratings on each three stories, for each intermediate measurement. To estimate the children's progress across different time periods during intervention (Second question), Chi-squared tests were performed, computing the prevalence in each rating level. Wilcoxon Signed-ranks tests were also conducted to compare the children's performance on each two measurements (differences between: first- second measurements, second- third measurements and first-third measurements). Furthermore, Friedman test was computed to compare the mean scores for each comprehension skill on the intermediate measures.

RESULTS

The efficacy of the intervention program in promoting comprehension skills among at-linguistic risk children

Prior to intervention, Man-Whitney test points on non- significant difference in the prescreening comprehension test between the intervention ($M= 38.25$, $SD= 8.43$) and comparison group ($M= 37.05$, $SD= 8.56$), where poor performance was noted in both groups. This result indicates that the initial level of both groups was similar.

Wilcoxon Signed-ranks test points on significant gains in comprehension skills within the intervention group, following their participation in the intervention program, as indicated by their significantly higher performance in the post screening comprehension test ($M=86.95$, $SD=8.43$) when compared to their performance prior to intervention ($M= 38.25$, $SD=8.90$). Also, Significant difference ($Z=-3.44$, $p<.01$) obtained in the comparison group performance in the post-test ($M=49.50$, $SD=13.38$) in comparison to their performance in the pre-test ($M=37.05$, $SD= 8.65$).

Despite of the progress within the comparison group performances, after intervention (by the end of the scholastic year), the intervention group ($M=86.95$, $SD=8.43$) showed on a significantly higher performances ($Z=-3.92$, $p<.001$) than the comparison group ($M=49.50$, $SD=13.38$) (See Figure 1).

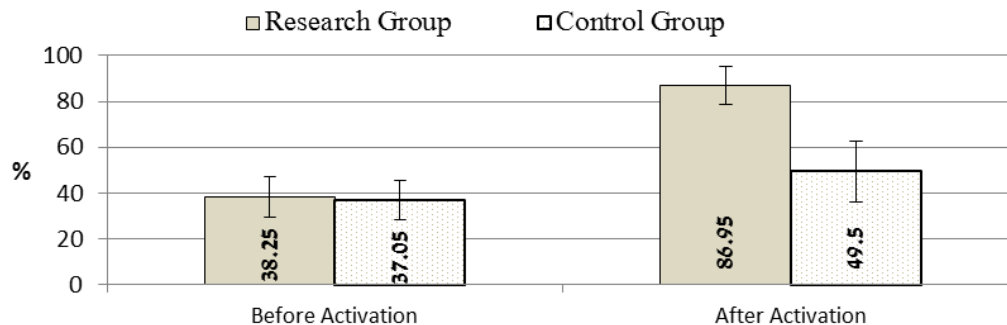


Fig 1. Differences in comprehension skills between the study (N=20) and comparison group (N=20) before and after intervention

To sum up, the obtained results indicate that the intervention program was successful in improving comprehension skills among the intervention group whereas the performance of the comparison group remained significantly lower. Thus, the results suggest that early intervention addressing comprehension skills may significantly assist at-linguistic risk children in their road of becoming proficient readers and consequently impede future academic failure. In addition, the results emphasize the role of learning environment that accommodates itself to the individual needs of each child in advancing struggling children and maximizing the obtained gains.

Differences in comprehension skills components within the intervention group across the three measurements

Performance differences in the various comprehension skills were assessed within the intervention group, including immediate story recall, delayed story recall, explicit information retrieval and inference making.

Differences in Immediate Story Recall Performance

Figure 2 presents the percentages of the intervention group rankings distribution across the three measurements in immediate story recall skill.

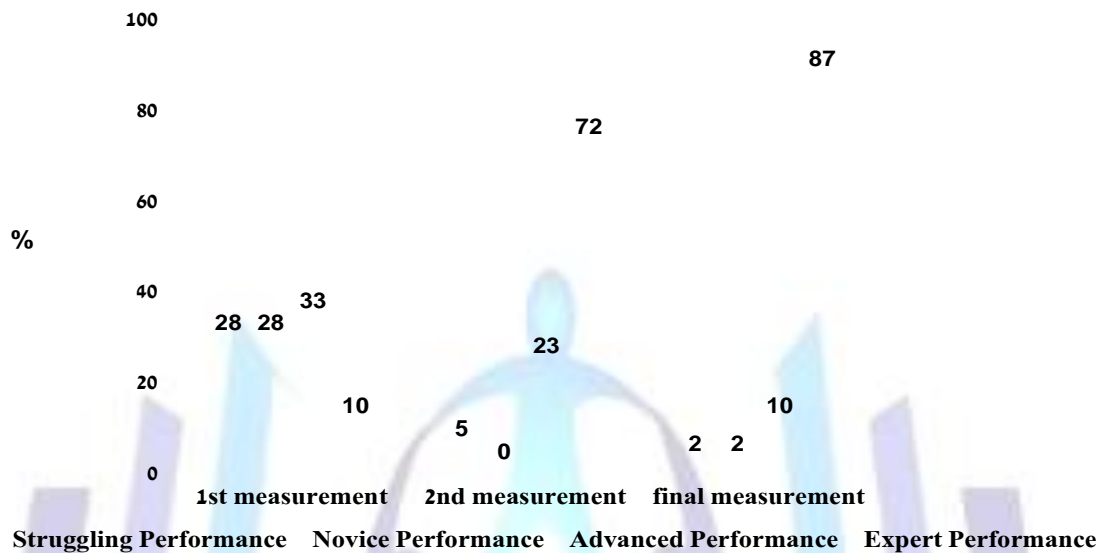


Fig 2. The intervention group immediate story recall rating distributions across the three measurements

To compare the children's rating distributions in the three measurements, Wilcoxon Signed -ranks test was conducted. The comparisons were done within every rating level (Skill level) between every two pairs of measurements: first and second measurements, first and third measurements and second and third measurements (see Table 3 Below).

Table 3. Differences in the intervention group rating distributions for the immediate story recall skill across the three measurements

skill level	Comparison (Wilcoxon)		
	M1-M2	M1-M3	M2-M3
Struggling Performance	-3.31***	-3.31***	.00
Novice Performance	-3.15**	-3.18***	-1.00
Advanced Performance	-1.41***	-2.36*	-2.45*
Expert Performance	-3.56***	-4.00***	-2.30*

* $p < .05$

** $p < .01$

*** $p < .001$

As presented in Figure 2 and Table 2, in the first measurement, higher distribution of children was concentrated in the first two categories "Struggling Performance" and "Novice Performance" (28% in each) whereas 33% were qualified for the "Advanced Performance" category and only about 10% for the "Expert Performance" category. Towards the end of the intervention, in the third measurement, the number of the children within the "struggling performance" category has decreased, as they progressed to "Advanced performance" category. Within the "Expert performance" category, the difference between the first and third measurements was significantly significant ($Z = -4.00, p < .001$). The children's progress is already noted in the second measurement where the percentage of children within the category "Struggling performance" (only 5%) has significantly decreased ($Z = -3.31, p < .001$) when compared to the first measurement (28%). Similarly, significantly lower percentage ($Z = -3.15, p < .001$) of children was encountered in the "Novice performance" category when comparing the first measurement (28%) to the second one (0%). Significant improvement ($Z = -2.30, p < .05$) was also noted between the second and third measurements where more children progressed to "Expert performance"

category (from 72% to 87 %). The percentage of assessments within the category "Expert performance" between the first and third measurements was statistically significant ($Z=-3.76, p<.001$) showing on the tremendous change in the percentage distribution of the children performances: at the first measurement only 21% of the children fall within "Expert performance" category whereas in the third measurement 87% of the children progressed to this category. The obtained results indicate on a positive and dynamic advancement in the children's immediate story recall skill.

In conclusion, throughout the intervention, the variance in the children's performance on the immediate story recall skill across first and second measurements has decreases substantially in the last measurement, carried upon the intervention termination. The obtained results indicate on the contribution of the program in inducing improvement in the immediate story recall skill.

In the first measurement, all children showed difficulty in both maintaining correct story sequence and in providing detailed answers. Children who were ranked as "Advanced" and "Expert" demonstrated capacity to use story schema in standardized Arabic. Expert children were able to present the story main details, showed basic abstraction ability and sequencing, distinguished relevant from irrelevant information and used full story schema.

Differences in Delayed Story Recall Performance

Figure 3 depicts the percentages of the ratings distribution within the intervention group in delayed story recall skill in the three measurements.



Fig 3. The intervention group delayed story recall rating distributions across the three measurements

Table 4 illustrates the change in the percentage of children in each rating between every pair of measurements using nonparametric test for paired samples (Wilcoxon).

Table 4. Differences in the intervention group rating distributions for the delayed story recall skill across the three measurements

Rating\category	Comparison (Wilcoxon)		
	M1-M2	M1-M3	M2-M3
Struggling Performance	-2.48*	-3.21***	.45
Novice Performance	-3.42***	-3.42***	.00
Advanced Performance	-.11	-1.57*	-2.19*
Expert Performance	-3.02**	-3.76***	-2.35*

* $p<.05$

** $p<.01$

*** $p<.001$

As indicated by Figure 4 and Table 4, the intervention group showed high variance in delayed story recall performance, especially in the first measurement. The children were evaluated two days after the weekly opening session (i.e. two days after they first heard the story and performed the immediate recall activity). In part their performance is affected by the quality of instruction in the weekly opening session, including the adequacy of the obtained tutor mediation that guides their learning of story scheme principles. It is worthy to note that the story content difficulty level and richness increased as sessions progressed. In the first measurement, the percentage of children ranked as "Expert" was the lowest (20.8%) when compared to the other ranking percentages, which increased significantly in the second measurement (59.2%) ($Z=-3.02, p<.001$). In the last measurement, a decrease in the children's distribution across the ranking categories is noted. Eighty percent of the children were ranked as "Expert" and 16% as "Advanced", where significant difference was encountered between the first and third measurement ($Z=-3.76, p<.001$; $Z=-1.57, p<.05$, respectively).

In conclusion, the obtained results suggest that the children showed a marked progress in delayed story recall, as emphasized by their capacity to recall the story while utilizing adequate story schema structure on the subsequent session, after exposed to it only once in the weekly opening session. A deep internalization of a story schema is noted as they progressed throughout the program as seen in the quality of their responses. In the last measurement, only 5% of the children were ranked as "Struggling" and "Novice".

Differences in Retrieval of Explicitly Stated Information Skill

Figure 4 presents the percentages of the ratings distribution within the intervention group in explicitly stated information skill in the three measurements.

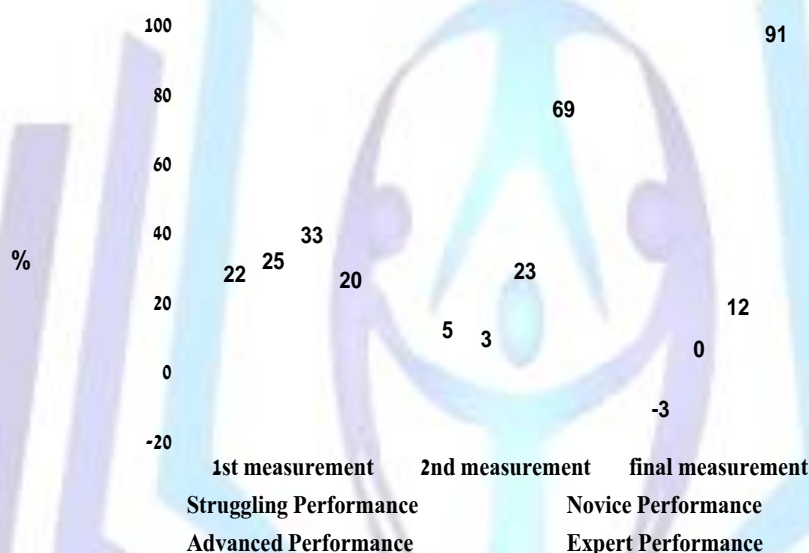


Fig 4. The intervention group explicitly stated information skill rating distributions across the three measurements

Table 5 illustrates the change in the percentage of children in each rating of explicitly stated information skill between every pair of measurements using nonparametric test for paired samples (Wilcoxon).

Table 5. Differences in the intervention group rating distributions for the explicitly stated information skill across the three measurements

Rating\category	Comparison (Wilcoxon)		
	M1-M2	M1-M3	M2-M3
Struggling Performance	-3.35***	-3.35***	-1.00
Novice Performance	-3.50***	-3.67***	-1.63
Advanced Performance	-2.05*	-3.46**	-3.37**
Expert Performance	-3.87***	-3.94***	-3.48***

* $p<.05$

** $p<.01$

*** $p<.001$

As indicated from Figure 4 and Table 5, in the first measurement 48% of the children's performances fall within the category "Struggling performance" and "Novice performance". In contrast to the first measurement, including only 20%

"Expert performance", 91% of the children were identified as such in the last measurement, suggesting a significant progress in retrieval of explicitly stated information skill ($Z=-3.94, p<.001$).

The noted progress in the children's responses on the identification of explicitly stated information measure can be related to the contribution of their improvement in immediate story recall along the performed measurements. In general, children who successfully performed the immediate story recall activities, succeeded in locating, identifying and recalling relevant details when answering the questions. In contrast, children who were less receptive to the tutors' mediations and showed difficulty in immediate recall measure, struggled with identifying explicitly stated information, also due to their poor vocabulary knowledge. However, an improvement was noted in as the children progressed along the program, paying more attention to the tutors' instructions (see Appendix 1 example num. 1).

Differences in making straightforward inferences skill

Inference is high-order cognitive skill that requires deep understanding of the text that allows drawing conclusions and inferring beyond stated information. This skill is influenced by personal experience, knowledge, instruction and contextual cues that guide the reader throughout the process of inferring. Impairment in each of these components might hinder comprehension. Figure 5 and 6 describe the differences in straightforward inference making skill in the intervention group.

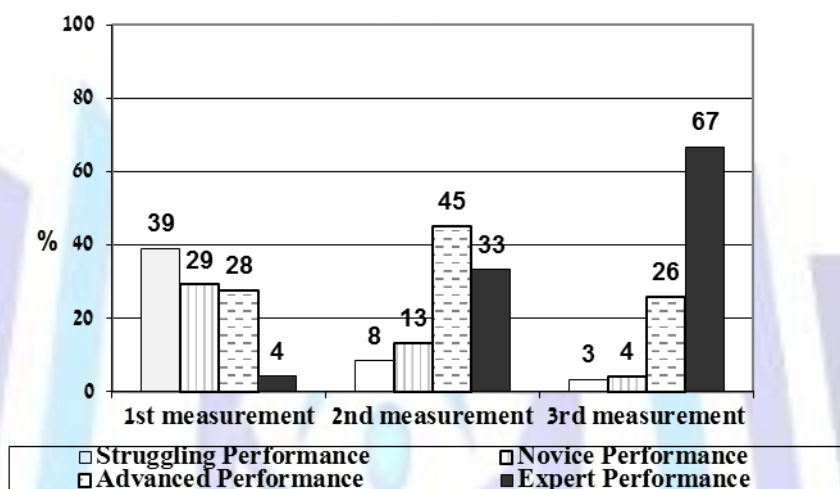


Fig 5. The intervention group's distribution on straightforward inference making skill across the three measurements

In the first measurement, the children demonstrated a poor capacity in identifying the main idea of the text and in interpretation and integration where 68.3% of the children were identified as "Struggling performance" and "Novice performance". Significant progress in the children's performance was observed in the second measurement as suggested by the increase in the percentage of children qualified as "Expert performance" ($Z=-2.35, p<.05$); 45% were identified as "experts" compared with only 27.5% in the first measurement. In the last measurement, the percentage of children within the categories "Expert performance" and "Advanced performance" was 92.5%. When compared to the first measurement where only 4% of the children performance fell in the category "Expert performance", significant improvement in inference skills is obtained in the last measurement, as 67% are identified as experts ($Z=-3.74, p<.001$). Thus, the children succeeded in understanding implied information in the text, improving their skill in drawing conclusions and making inferences by relying on contextual cues, understanding intra-textual connections and personal experience.

Table 6 illustrates the change in the percentage of children in each rating of straightforward inference making skill between every pair of measurements using nonparametric test for paired samples (Wilcoxon).

Table 6. Differences in the intervention groups rating distributions for straightforward inference making skill across the three measurements

Rating/category	Comparison (Wilcoxon)		
	M1-M2	M1-M3	M2-M3
Struggling Performance	-3.75***	-3.85***	-1.00
Novice Performance	-2.28*	-3.45***	-1.93
Advanced Performance	-2.35*	-4.33	-2.28*
Expert Performance	-3.30***	-3.74***	-3.08**

* $p<.05$

** $p<.01$

*** $p < .001$

The children performance on the specific straightforward inference making skill, as assessed in the current study (main idea identifying and interpretation and integration) is described. Figure 6 presents the percentages of the ratings distribution within the intervention group in main idea identifying across the three measurements.

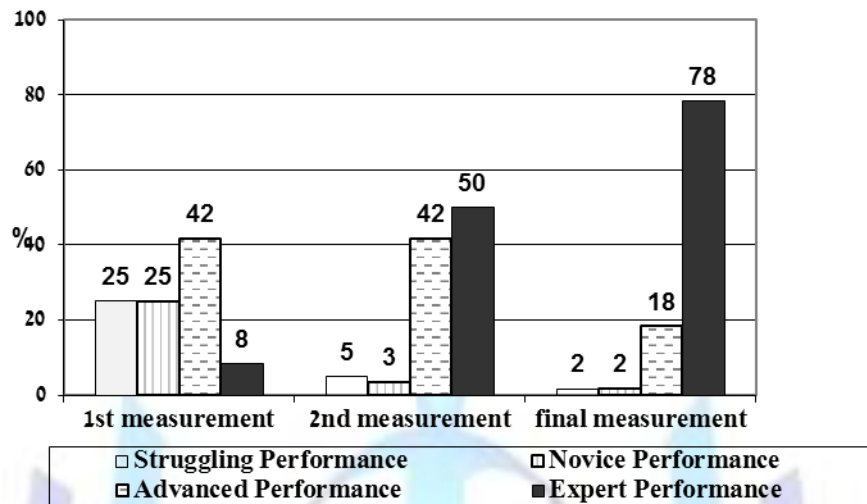


Fig 6. The intervention group's performance in identifying the main idea across the three measurements

Table 8 illustrates the change in the children's percentage for each rating category as a function in the main idea identification measure. Wilcoxon signed rank test was carried to assess the difference in performance between the measurements.

Table 7. Differences in the intervention group rating distributions for the main idea identification component across the three measurements

skill level	Comparison (Wilcoxon)		
	M1-M2	M1-M3	M2-M3
Struggling Performance	-3.42***	-3.42***	.00
Novice Performance	-2.97**	-3.12**	-.58
Advanced Performance	.00	-1.79	-2.13*
Expert Performance	-3.35***	-3.74***	-2.41*

* $p < .05$

** $p < .01$

*** $p < .001$

As seen in Table 7 and Figure 6, the results indicate that the children's ability to identify the story main idea has improved significantly from the first to the last measurement, following their participation in the program ($Z = -3.74, p < .001$). In the last measurement, 78.3% of the children's performance was assessed as "Expert performance" as opposed to only 8.3% in the first measurement. During the program implementation period, the children were required to learn how to identify the story main idea, following the tutors explanations, mediation strategies and exemplification. With more experience, greater gains in performance are noted (See Appendix A, Example 2).

Similarly, significant progress was also noted on the interpretation and integration component (See Table 8 and Figure 7).

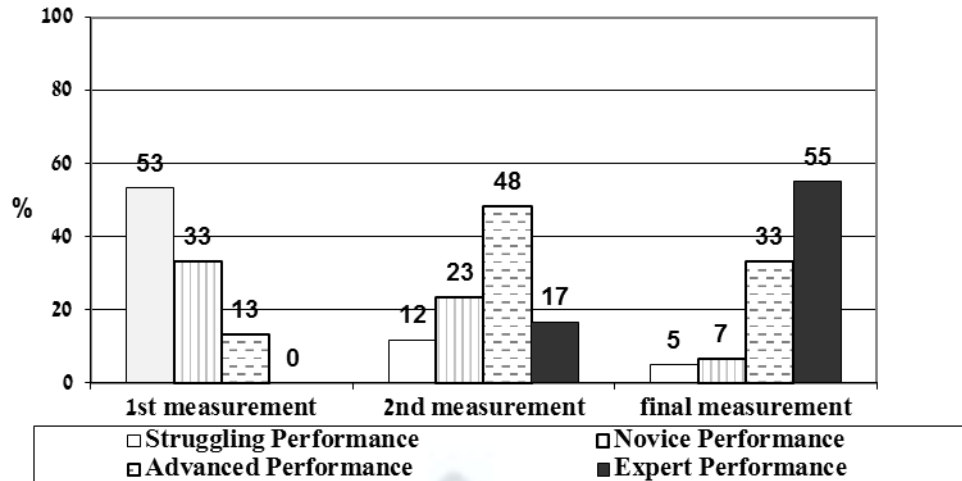


Fig 7. The intervention group interpretation and integration performance across the three measurements

Table 8 illustrates the change in the children's percentage for each rating category in the interpretation and integration measure. Wilcoxon signed rank test was computed to compare the difference in performance between every pair of measurements.

Table 8. Differences in the intervention groups rating distributions for interpretation and integration component across the three measurements

skill level	Comparison (Wilcoxon)		
	M1-M2	M1-M3	M2-M3
Struggling Performance	-3.70***	-3.91***	-1.00
Novice Performance	-1.08	-2.86**	-1.88
Advanced Performance	-2.87**	-2.24*	-1.37
Expert Performance	-2.23*	-3.46***	-3.07**

* $p < .05$

** $p < .01$

*** $p < .001$

In the first measurement, most of the children's performances (86%) were identified as "performance" and "Novice performance", where none of the children achieved the "Expert performance" ranking. In contrast, 55% of the children performances were identified as "Expert performance" in the last measurement, reflecting the intervention group significant progress in interpreting and integrating information at the end of the program ($Z = -3.46, p < .001$). Additionally, another statistically significant progress in the children performances is seen between the second and third measurements ($Z = -3.07, p < .01$); while in the second measurement only 17% of the children's performances fell in "Expert performance" category, in the third measurement 55% of the children performances were categorized as "Expert performance". In the third measurement, only 5% of the performances were classified as "Struggling performance", showing on a significant progress ($Z = -3.91, p < .001$) in comparison to the first measurement (53%) (See Appendix A, Example 3).

Summing the Differences in Comprehension Skill Across the Three Measurements

Figure 8 presents the mean scores of the various comprehension skills across the different intermediate measurements. Friedman test was conducted to compare the differences in the children's mean scores between the skills in each measurement.

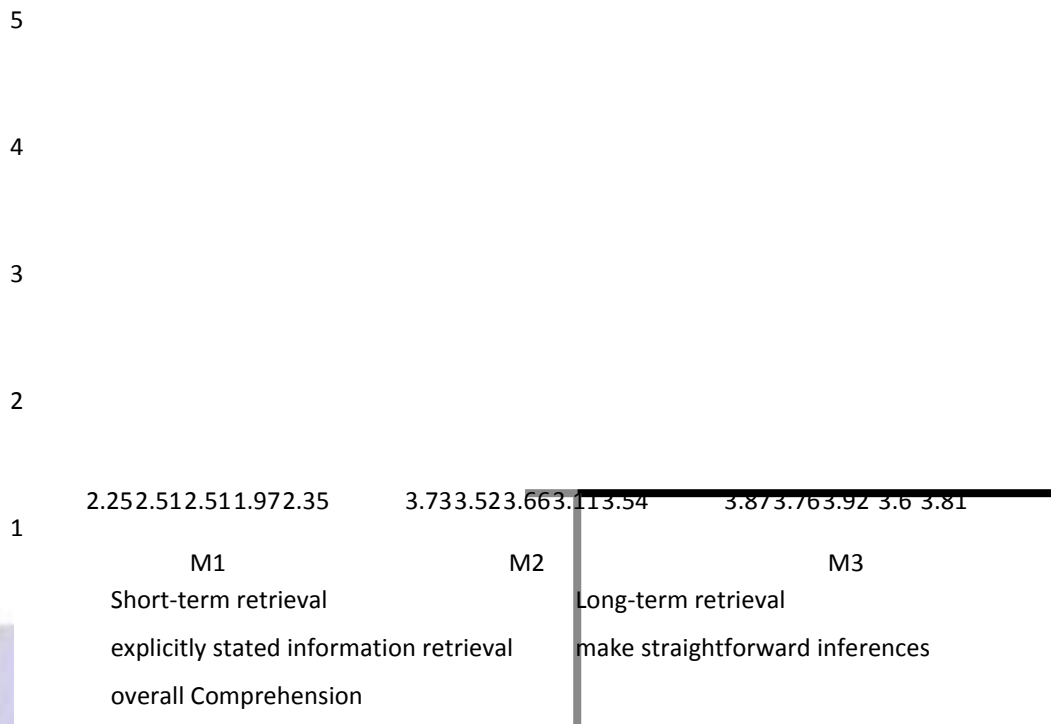


Fig 8. The intervention group children's mean scores in the different comprehension skills across the three measurements

In the first measurements, significant difference was obtained between the different comprehension skills ($\chi^2(3) = 30.82, p < .001$). Higher performance was obtained on the delayed story recall measure ($M = 2.51, SD = .52$) when compared to explicitly stated information retrieval skill ($M = 2.51, SD = .44$), immediate story recall ($M = 2.25, SD = .57$) and making straightforward inferences ($M = 1.97, SD = .40$).

A significantly higher performance among the intervention group was noted in the second measurements ($Z = 3.92, p < .001$). Differences in the children's performance was also noted between the various comprehension skills ($\chi^2(3) = 31.95, p < .001$): immediate story recall ($M = 3.73, SD = .37$), retrieval of explicitly stated information ($M = 3.66, SD = .30$) and making straightforward inference ($M = 3.11, SD = .53$).

Indeed, the overall performance of the children in comprehension has significantly improved where higher overall mean score was obtained in the first and third measurements ($Z = 3.92, p < .001$) and between the second and third measurements ($Z = 3.50, p < .001$). Differences in performance between the various comprehension measures were also obtained ($\chi^2(3) = 20.41, p < .001$). Higher performance was observed in the immediate recall measure ($M = 3.73, SD = .37$) when compared to delayed story recall ($M = 3.66, SD = .30$), retrieval of explicitly stated information ($M = 3.66, SD = .30$) and making straightforward inference ($M = 3.11, SD = .53$).

The presented results point on an improvement trend in the children's comprehension skills across the different measures. The highest performance on the delayed recall measure in the first measurement is the consequence of the activities that children were exposed to after reading the story and coincidentally with their progress along the program and acquisition of strategic skills, optimizing their ability to construct an adequate story schema. In addition, the improvement in vocabulary and implementation of reading strategies may account to the progress noted in retrieving explicitly stated information. Ultimately, despite the improvement in inference skills, it remained the most challenging skill for the children to master, reflecting its cognitively demanding nature.

In conclusion, during the 26 sessions, the gains from participating in the intervention program were reflected in all the assessed comprehension skills: immediate and delayed story recall, retrieval of explicitly stated information and straightforward inference making. However, only 55% of the students were qualified for the "expert" ranking on the inference measure in the last measurement, which is considerably lower than their performance on the other measures. This finding can be explained by the dependency of this skill on a vast array of competencies such as, vocabulary, verbalization and verbal reasoning, syntax, written expression abilities and background knowledge. Furthermore, this skill seems to follow a developmental trend, expected to consolidate during schooling years.



DISCUSSION

The aim of the present study was to investigate the efficacy of a balanced interactive intervention program in promoting comprehension skills and vocabulary among at-literacy risk Arab children. The obtained results provide new insights to reading acquisition and comprehension processes, expanding the existing scientific data and carrying pedagogical implication for the instruction of reading literacy

The primary findings of this study relates to the obtained gains in comprehension skills within the intervention group, following the intervention program's implementation in comparison to the comparison group. The results indicated that the participation in a balanced interactive intervention program promoted the comprehension skills of the intervention group, as reflected in their higher post-test performance when compared to the comparison group. Initial homogeneity in comprehension skills was established prior to the program commencement; which was seen in the pre-test performance. All the children in the intervention group advanced to "Expert performance", hence mastering the necessary comprehension skills and exhibiting richer vocabulary. Accordingly, in addition to the curricular literacy activities implemented in class, our findings stress the necessity of a complementary balanced remedial program in order to enable at-linguistic risk children to close the gaps with their peers and master the required literacy skills.

Similarly, Makhoul & Ibrahim [48] suggested that promoting literacy knowledge among at-linguistic risk children is essential but not sufficient for reading acquisition. A successive structured remedial program is a key element in enabling at-risk children to close the gaps in reading competencies, to ultimately mastering the required skills for deriving meaning out of written texts. In the case of Arabic, poor literacy skills, low SES and Arabic's socio-linguistic feature intertwine to create a triad of risk factors obstructing reading and writing acquisition, necessitating a longitudinal intervention that draws on Adam's interactive model principles [46; 51;52].

When considering the optimal teaching approaches of reading comprehension, the program incorporated practices that influence both semantic and contextual processors, contributing to decoding and meaning construction. Since novice readers efforts are mostly invested in decoding, restricting their ability to derive meaning out of written texts, semantic and contextual knowledge can contribute to reading comprehension [68; 69; 54; 35]. Accordingly, one of the program's goals was to supply the children with suitable reading comprehension strategies. Meaning construction and context assist children in establishing grapheme-phoneme correspondence, by supplying online feedback to his reading performance [56]. The reciprocal relationship between reading and comprehension, reflected in the involvement of both "top-down" and "bottom-up" processes, underlined the construction of the current computer-assisted tutoring intervention program. As indicated by the study results, simultaneous phonological and meaning construction training and practices contributed to the acquisition of the necessary reading skills, where significantly better reading comprehension attainments were achieved after intervention when compared to the pre-test. Thus, interactive remedial practices are fundamental for closing literacy gaps.

In the current study, we examined the effect of a proposed intervention program on promoting the different components of comprehension and vocabulary in the intervention group: immediate story recall, delayed story recall, retrieval of explicitly stated information, straightforward inference and interpretation and integration of information.

Throughout the program implementation, an improvement in immediate story recall was noted among all participating children, advancing from "Struggling performance" to "Expert performance" (Figure 2). Additionally, a decrease in the children's performance variance was noted in the last measure when compared to the two previous measures where 87% were ranked as "Expert performance".

An initial variance between the children was also observed in the delayed recall skill that decreased following the children's progress in the program (Figure 3). The performance of the children indicates to the suitability of the implemented teaching practices and content, promoting internalization of a story structure scheme.

When required to retrieve explicitly stated information on the pre-rest, poor performance was noted where only 20% of the children achieved "Expert performance" in comparison to 91% in the last measurement (Figure 4). This skill is partly reliant on immediate story recall capacities: complete recall while utilizing the corresponding story schema enables successful identification, detection and recall of information stated in the text.

When relating to inference skill, two components were addressed: making straightforward inferences (identifying the main idea) and interpretation and integration of content. In the last measurement, a significant progress was observed in the children's overall inference where 66.7% were ranked as "Expert performance" in comparison to only 4.2% in the first measurement, indicating to their success in arriving to deep understanding of the text and to integrate information within the text to make inferences (Figure 5). Specifically, in light of their participation in the program, the children showed significant progress in identifying the main idea of the story and making inferences; however, they did not arrive to complete mastery of the later. It is worthy to note that regardless of the literacy level, inference is an intricate process, requiring higher order thinking that follows a developmental path [66; 70]. Inference skill is subject to cognitive development and is influenced by the quality of instruction and experience. The results of the current study pointed to moderate improvement in inference skill, however, extensive and successive instruction is still required throughout the upcoming scholastic years. Thus, despite the moderate improving in inference skill, it cannot be concluded that the program was not effective in promoting inference competencies, where great portion of the participating children arrived to "Expert" ranking.



An improvement trend is noted for each of the different comprehension skills (Figure 9) across the different measurements, accompanied by increase in vocabulary, story schema internalization and application of reading comprehension strategies. In the first measurement, highest performance was observed on the delayed story recall measure because of its reliance on the incorporated activities and the learning process occurring after their initial exposure to the story, where it continued to improve during the course of intervention. Similarly, following the observed increase in their vocabulary and the utilization of reading strategies, the intervention group also showed significant improvement in inference and retrieval of explicitly stated information.

Interestingly, Hussien [71] suggested that comprehension is one of the predictors of oral reading fluency in Arabic. In the current study, the achieved improvement in comprehension skills reflects on the children's reading fluency. During the first stages of program, the children were exposed to the stories orally as they were commencing to acquire the building blocks of reading, to gradually independently engaging in reading as they progressed along the program. Accordingly, the improvement in comprehension skills might account in part for their progress in reading fluency, as seen in their continuous progress across the skills, which greatly depended on their reading skills.

The vocabulary repertoire incorporated in the current program has drawn on high frequency and age-suitable words that sets the ground for vocabulary growth. The interrelatedness between vocabulary and comprehension has been very well documented in the scientific literature. According to the golden DVC (Decoding, Vocabulary and Comprehension) model [72], illustrating the reciprocal nature between linguistic and cognitive components underlying reading skill, decoding, vocabulary and comprehension form a triangular set of constitutions where direct relationship is seen between vocabulary and comprehension and between vocabulary and decoding. Moreover, it assumes that vocabulary is the mediating constituent between decoding and comprehension, giving feedback to the reader by verifying the meaning of the read word in the lexicon. Hence, comprehension that is the outcome of word knowledge promotes skillful decoding.

The nature of the current intervention program points to and strengthens the relationship between reading and listening comprehension. In the initial stages of reading acquisition, children's efforts are mainly invested in decoding and less for meaning construction. Consequently, children are usually exposed to simple and short texts, thus confronted with only dull sentence construction, vocabulary and content. To enable exposure to richer texts and promote comprehension skills, richer texts were presented *auditory presentation of richer texts was incorporated in the intervention program (i.e. read to them by the tutor)*. There is a discrepancy between the child's ability to read a text and enjoying in listening to a read text. Reading aloud a text by the tutors exposes the children to much intricate texts, when still lacking the required capacities to assume responsibility for their reading activities. Shared reading exposes the child to richer vocabulary and texts that are more suited to his interests, making reading a much enjoyable and interesting means for knowledge acquisition. Thus, we assumed that engaging in listening comprehension activities at the early stages nourishes later reading comprehension skills.

The dynamic characteristics of the program add to its uniqueness where improvement in comprehension skills is noted on each of the carried measurements, thus facilitating continuous progress along the course of its implementation. The multiple measurements conducted throughout the program served as an index for the children progress on the developmental continuum of comprehension skills, both qualitatively and quantitatively, allowing deeper understanding of the obtained results. Ultimately, at-linguistic risk children necessitate interactive dynamic intervention program in order to improve their comprehension skills.

Additional advantage for the current program resides in its computerized nature. Computer-assisted tutoring learning environment enables the presentation of information via two channels – auditory and visually [73; 60]. The diversity in the content manner of presentation, allowing repeated exposure in different means (i.e. video, texts, pictures and audio) is assumed to have had an impact on the outcomes of the learning process. The multiple modalities of presentation has been proven to be beneficial for children with reading disabilities, especially in promoting phonological awareness skills and letter-sound corresponds and in improving comprehension skills [e.g. 74; 75]. Such flexibility allows compensating on the child weakness by focusing on his strength. In contrary to printed books, computerized environment allows manipulation of multiple features that can be set to meet the needs of the student [76].

Nowadays, researchers like Perffeti and Stafura [77], stress the importance of word orthographic identification in comprehension. In the case of Arabic, the orthographic complexity of Arabic adds to the cognitive load experienced by novice readers [71]. Thus, the auditory and visual facilitation characterizing computerized environments may compensate for Arabic orthographic complexity and by that promoting reading comprehension, especially among at-linguistic risk children.

Conclusions

The study's findings raise several implications for reading instruction among at-linguistic risk children, especially in Arabic. Based on the current findings, scientific and pedagogical-educational schemas were constructed. The scientific schema (Illustration 1), describes and sums the current study's procedure, pointing to the effectiveness of the implemented intervention program on improving comprehension skills, while taking into account the role of motivation on the achieved progress. On the other hand, the pedagogical-educational schema presents a guiding framework for learning content developing and education policy legislation, establishing the key components for effective reading and writing remedial program (Illustration 2).

Early intervention prevents later academic failure. Reading instruction should be accommodated to fit the needs of each child. Inadequate reading instruction may lead to failure in reading acquisition and hinder reading performance. In the



present study, regular in-class instruction has proven to be insufficient in addressing at-linguistic children's needs and their characteristics. Hence, additional complementary interactive remedial instruction is required.

In Initial stages, struggling children necessitate individual reading instruction environment in order to enable adequate reading acquisition and improve their performance. Accordingly, for each child, an individualized learning program that controls for operating risk factors (i.e. low motivation, linguistic characteristics of the language) and takes into account the child's characteristics should be developed.

Learning environment is a crucial element in determining the degree of the children's achieved progress. The variance that was initially noted between the children in comprehension skills has decreased following the implementation of effective learning strategies occurring in a suitable learning environment that enhances the children's motivation and accommodates itself to their individual needs. The balanced approach (interactive learning environment), contribute to literacy skills' promotion and improves children's learning experience.

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Appendix A –

Example Responses of the Children on the Different Comprehension Measures

Example no.	
1	<ul style="list-style-type: none">▪ Identification of explicitly stated information <p>The children's progress in identification of explicitly stated information can be exemplified by one of the children's responses when dealing with "The White Rabbit" story (11th story, last measurement).</p> <ul style="list-style-type: none">▪ Sample question: " why was the rabbit afraid of the animals?"▪ Response example: <i>" The rabbit was afraid of predatory animals, built a very strong house and hid in it. When the devious fox came, he couldn't enter to her house. I also run home when I feel afraid. Once Hamoudi wanted to hit me and take my new pencil so I quickly ran to my house and called my brother out which made Hamoudi feel afraid to get near me.</i> <p>The above presented example reflects good understanding of the story and richness in vocabulary.</p>
2	<ul style="list-style-type: none">▪ Inference – main idea identification <p>For example, when required to give alternate title to the story, one of the children responded:</p> <p>" The smart rabbit and the stupid wolf"</p> <p>The presented response reflects the child's ability to identify the story main idea, obtaining the "expert" rank.</p>
3	<ul style="list-style-type: none">- Inference- drawing conclusion▪ Sample question: <i>" what will happen to the wolf after being invited by the rabbit to enter via the roof?"</i>▪ Response example: <i>" The wolf attempted to enter via the roof, fell into a pot of boiling water and died.. he deserves it. The rabbit was smart, she managed to trick him and got rid of him. I also know how to react; when strangers speak to me I don't answer and run home quickly, I need to be careful"</i> <p>The above presented response is well detailed, reflecting basic abstraction and generalization abilities.</p>