

Foundations to Literacy's Study Plan

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1. Introduction

This is a technical document that describes the structure and workings of the study plan underlying the Foundations to Literacy (FtL) reading program. For detailed discussions of the context and history as well as the scientific and technological bases of the program, refer to Wise, Cole et al., 2008; Wise & Van Vuuren, 2007; Cole, Wise, & Van Vuuren, 2007; and Van Vuuren, 2007; Wise, Ring & Olson, 2000; Wise, Ring & Olson, 1999; Wise & Olson, 1995)

FtL is a scientifically-based program designed to teach reading with the help of a computer and a pedagogical agent called *Marni*. It builds on the highly effective Reading with ROSS computer program (Wise, Ring, & Olson, 1999; 2000; Wise & Olson, 1995). ROSS provided phonological activities and book reading with help provided by a synthetic voice and a human research teacher, present every day but reading with each child only once a week. *FtL* replaces the synthetic voice with human speech and the research teacher with an animated agent.

As described in (Wise, Cole, et al., 2008), *FtL* is grounded in the ‘Simple View of Reading’ (Gough & Tunmer, 1986) which describes reading comprehension as a product of the processes underlying Word Reading and processes underlying Language Comprehension. *FtL* provides some teaching of these processes within the five learning domains recommended by the National Reading Panel (NICHD, 2000): phonemic awareness, phonics, fluency, comprehension, and vocabulary.

FtL is designed for kindergarten (K) through 2nd grade students. However, exercise material is strongest in KG and 1st, with some book reading content into 4th grade. Students are presented with a variety of content and exercises, including reading skills exercises practicing foundational skills such as alphabet, phonics, phonological awareness, as well as interactive books which teach fluency with read out loud capabilities, and questions which test comprehension. Interaction between the user and computer is mediated by a pedagogical agent – a 3-D animated character with anatomically correct visual speech and facial expressions (Ma, et al., 2004), and a speech recognizer (Pellom, 2001; Hagen et al., 2004) which recognizes and tracks the student when reading aloud (Van Vuuren, 2003).

2. Plan structure and organization

FtL is presented as a virtual classroom environment from which students can choose several reading activities. The availability and sequencing of these activities is governed by a study plan that is designed as *a sequence of modules* of increasing difficulty, each module containing several activities. Besides permitting choice of activities in a module, the study plan is designed to be somewhat adaptive—managing time spent within activities in a module, adjusting the level in an activity, and adapting the number of items presented in a level. It reinforces learning and generalization with integrative teaching strategies that encapsulate supported and unsupported untimed *practice*, *time-limited* testing and retention testing. It is conditional, navigating the student through the program until these skills become *accurate* and *automatic*.

2.1 Classroom environment

Students log in to a classroom environment from which they can choose one of several reading activities (Figures 1 and 2). The student's name is shown on the green chalkboard and placement within the program within the bar at the bottom of the screen. The program presents the students with a sequenced selection of activities ranging from reading skill exercises to interactive books. Books that have been read are placed on a library bookshelf, and made available for later re-reading. A progress view is available by clicking on the items in a chart next to the library bookshelf. A clock shows how long the student has been working during the current session.

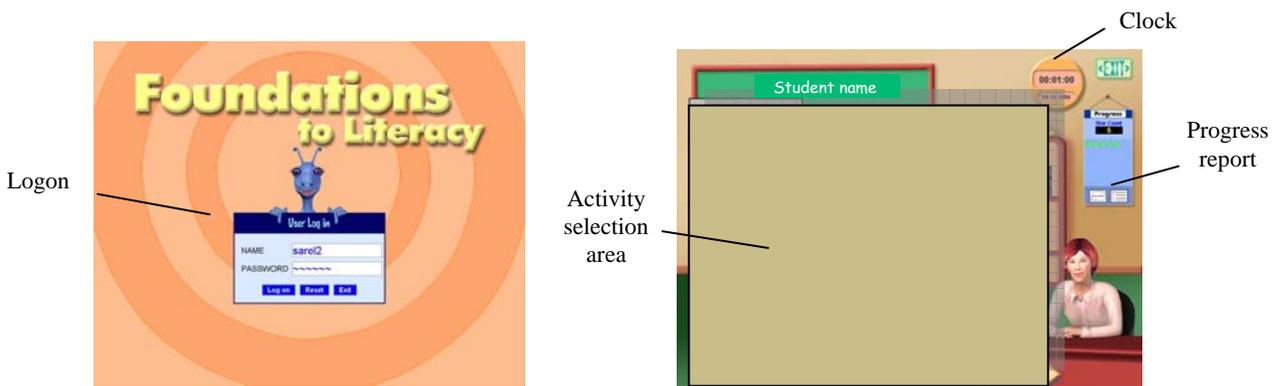


Figure 1. Foundations to Literacy logon screen and classroom environment. The student's name is shown on the green chalkboard. The program presents the students with a sequenced selection of activities. A progress report is available by clicking on the items in the chart next to the library bookshelf. The clock shows session time.

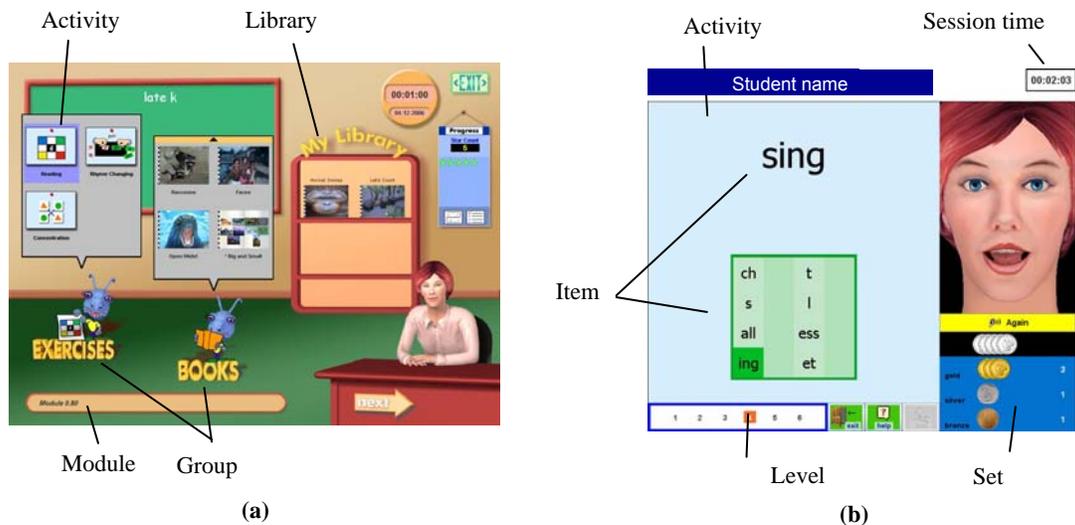


Figure 2. See text for detailed explanation. **(a)** Study plan session, group, module and activity elements in the classroom environment. The student can either choose one of several activities in the skills exercise and interactive book groups by clicking on that activity or select a default activity by clicking on a 'Next' arrow. Books that have been read are placed on a library bookshelf, and made available for later re-reading. The student is working on module 0.8, one minute into her current session. Placement within the program is shown in the bar at the bottom of the screen **(b)** Level, set and item elements in an activity. The user is building the *sing* item, the 5th item in a set of 10 items, working on level 4 of the Sound Blending activity.

2.2 Activities

Activities are grouped into two major types—*reading skills* activities which practice and test basic *reading skills*, and *interactive book* activities which practice and test *reading in context*, e.g. reading silently or aloud, and answering questions to test vocabulary, fluency or comprehension. Reading skills activities include:

- Lowercase and uppercase letters
- Letter sounds
- Beginning, middle and ending sounds
- Beginning blends
- Beginning changing, end changing, and rhyme changing
- Sound blending
- Vowel finding
- Regular (sound-out) and sight word reading
- Regular (sound-out) and sight word spelling
- Matching game

Appendix A lists the main activity types within FtL and their placement within modules, where they are grouped to complement or reinforce a particular skill, or provide different ways to practice the same skill.

2.3 Levels and Items

Each activity has several levels (Figure 3). At each level, the student is presented with one or more sets of 10 items (questions). Items are drawn randomly without replacement from a list specific to each level in each activity. Figure 2 showed the occurrence and placement of the study plan elements within the overall program.

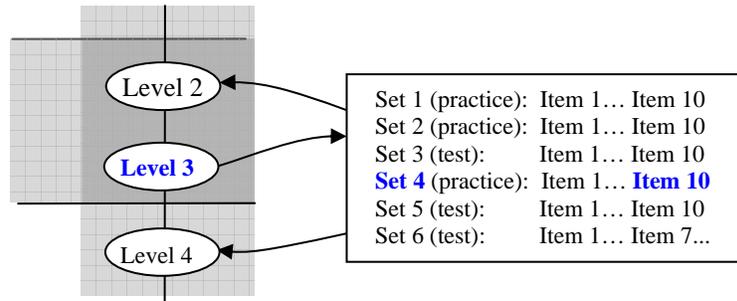


Figure 3. Study plan structure. The student is practicing the 10th item “find the word *hat*” in her 4th set, meaning she has already completed 3 sets of 10 items of similar questions. She is working at difficulty level 3 (See text for explanation.).

2.4 Modules

Study plan elements are organized and presented in a modular structure. Each grade consists of ten modules indexed by grade and module number starting at 0. Tables 1 and 2 list the specific skills taught by the program by module and grade.

Each module contains *activities* grouped at a similar skill level in such a way as to complement, reinforce or augment a particular skill or collection of skills in different ways. Figure 4 shows an example of grouping across modules.

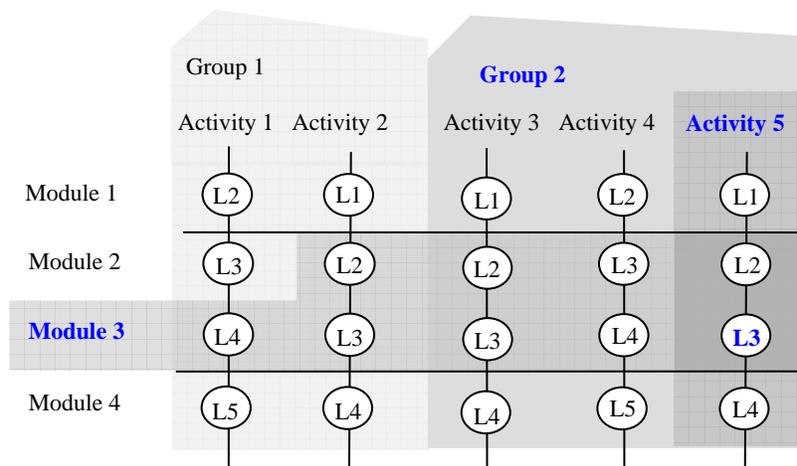


Figure 4. Study plan structure. The student is working at difficulty level 3 of activity 5 which she chose within group 2 for which she has been scheduled time in her 2nd session in the program. Each activity presents a different way to practice the skill specified in module 3 that she is currently working on. (See text for explanation.)

For example, module 0.5 is taught at a mid kindergarten level. Module 1.8 is taught toward the end of first grade. An activity may have several *levels* with successive levels increasing in difficulty. An activity may appear in more than one module, but activity levels are unique to a module. For example, the vowel find activity teaches middle sounds in module 0.5 (/man/), and silent-e in module 1.5 (/mane/).

Table 1. Specific alphabet, phonics and phonemic skills taught by the program as a function of grade and module.

	Grade/Module		
	K	1	2
Letters, Phonics, and Phonemic Awareness			
Letters and sounds			
Letter-sounds	• • • •		
Letters (upper & lower case)	• • • •		
Phonological awareness			
Initial consonants	• •		
Initial digraphs	•		
Middle vowels (short)	• •	• •	
Final consonants		•	
Final digraphs		• •	
Sound blending		• •	
Change onset	• •	•	
Change rime	• •	• •	
Identify onset and rime		• • •	
Phonics patterns			
Suffixes (-s, -ing)		•	
Short vowels		• • • •	
Long vowels (silent e)		• • •	
Open vowels (-i, -a, -o, -ay)		•	
Vowels with hard and soft c		•	
Vowel digraphs		•	• •
Diphthongs		•	•
Suffixes (-y, -ed, -est)			•
R-sounds		•	• •
Blends		•	• • • • •
R-blends (3 letters)			•

Table 2. Specific fluency skills taught by the program as a function of grade and module. Where applicable, books are listed by reading or grade level.

	Grade/Module																											
	0				1								2								3	4	5	6				
Fluency																												
Simple words																												
Regular word reading					•				•	•	•	•	•	•							•	•						
Regular word spelling					•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				
Sight words																												
Sight word reading					•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Sight word spelling									•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Reading in context																												
Concept books	A	A	A	B	B	B	B	B	B	C	C	C																
Decodable books					•	•			•	•	•	•	•															
Fiction/Narrative texts													D	F	H	J	J	J	K	K	L	L	•	•	•	•	•	•
Expository texts													1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
Comprehension																												
Picture																												
Picture concept	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•												
Text																												
Surface level	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Main idea													•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Inference													•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Vocabulary																												
Oral vocabulary																												
Tier 1	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

2.5 Sessions and activity groups

Students are assumed to spend typically 10-30 minutes at a time on the program. Within each such *session*, time is allocated across one or more groups of activities (Figure 4), covering foundational reading skills such as phonemic awareness, phonics and vocabulary, and fluent reading in context and reading for comprehension.



Figure 4. Study plan structure. The student is working within *group 2*, which she choose or was assigned to, and for which she has been scheduled time in her 2nd *session* in the program. (See text for explanation.)

Allocations within a group need not be contiguous within a session, with the student sometimes moved to a different group if the program determines a temporary change may aid learning. In all cases, the program waits for the student to finish the current task before changing groups. Overall the program tries to keep average time spend in a group within a target value.

Allocations per session for different groups are listed in Table 3. The actual allocations depend on the granularity of task performed. For example, the program waits for the student to complete logical tasks within an activity before changing the group.

Table 3. Time allocations (in minutes) per session for different groups of activities.

<i>Group</i>	<i>Grade level</i>				
	<i>K</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
Exercises: Regular word coding and decoding	10	9	7	4	4
Exercises: Sight word coding and decoding	2	2	2	2	2
Games: Matching game using exercise material	2	2	2	-	-
Books: Fluent reading and comprehension	8	9	11	16	16
Books: Rereading books	4	4	4	4	4
	26	26	26	26	26

2.6 Transitions

Modules are connected in a *state-transition network*. To move to a different module, the student has to meet the requirements specified for the transition between the current and new modules. Transition requirements are specified with logical relations across the activities in the module where individual elements in the relation can specify the level, number of sets and accuracy per set required for one or more activities in the module. Activities can be required or optional depending on whether they are included in the transition requirements.

3. Activity structure and flow

3.1 Instruction and practice. Having been assigned a module, group, activity, and *current* level within the activity, the student begins instruction (Figure 6) by being oriented to what is being taught. This is followed by several sets of *untimed* practice. Practice cycles between unsupported and supported modes. Accuracy on successive sets is used to measure performance. If performing poorly, the student is moved from unsupported to supported practice and back when performance improves. With continued poor performance the student is moved to a lower level in the same activity or to an appropriate level in an easier activity. If performing well, the student is provided with *timed* practice and optional additional practice or games to reinforce the concept or skill before being moved to a higher level in the same activity or an appropriate level in a new more difficult activity. The timed practice is also used as an assessment.

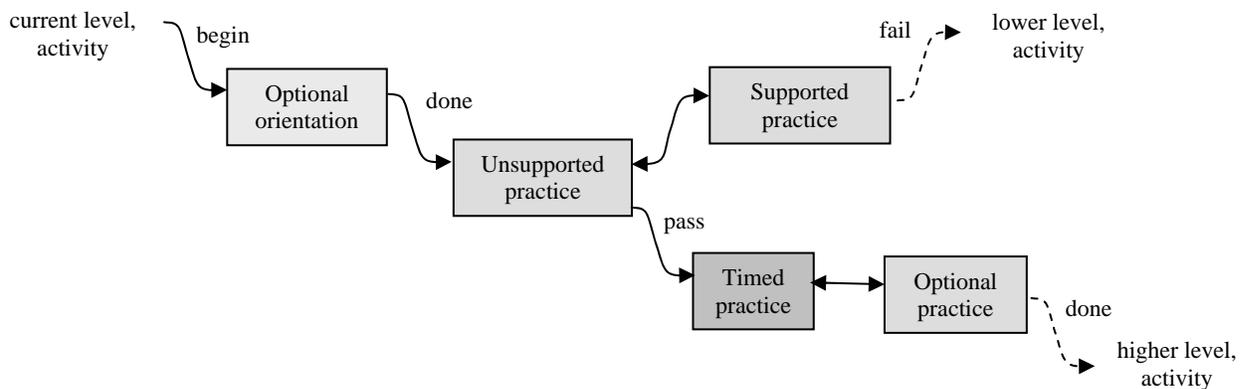


Figure 6. Instruction. (See text for explanation.)

3.1.1 Untimed practice. Untimed practice consists of one or more sets of ten items each and cycles between unsupported and supported modes (Figure 7). During *supported* practice the student can listen to and change the choice before submitting the answer. During *unsupported* practice the student submits the choice when it is selected. In both cases, the animated coach provides detailed verbal feedback on the validity of the submitted choice to reinforce learning. Accuracy on successive sets is used to measure performance. Each set consists of 10 items (questions and answers). During supported and unsupported practice students are allowed up to three tries (answer attempts) per item, although accuracy is measured only on the first try. If performing poorly, by achieving less than 60% correct in a set, or 4 successive items wrong, the student is moved from unsupported to supported practice. The student is moved back to unsupported practice when performance improves, achieving 80% correct in a set or 8 successive items correct. With continued poor performance, by achieving less than 20% correct in a set, or 5 successive items wrong, the student is moved to a lower level in the same activity or to an appropriate level in an easier activity. If the student seems to have difficulty answering the items, with two successive wrong answers, the number of choices are reduced to a default of 3 choices. Conversely, with two successive correct answers, the number of choices is increased to the default of 4 to 5 choices. If performing well, by achieving more than 80% correct on two successive sets or 10 successive items correct, the student is provided timed practice and optional additional practice or games to reinforce the concept or skill before being moved to a higher

level in the same activity or an appropriate level in a new more difficult activity. After several minutes in the activity, after completion of the current set, the activity temporarily ends at which point the group changes or the student is allowed to choose the same or a new activity. Appendix B lists *activity-specific* deviations from this description.

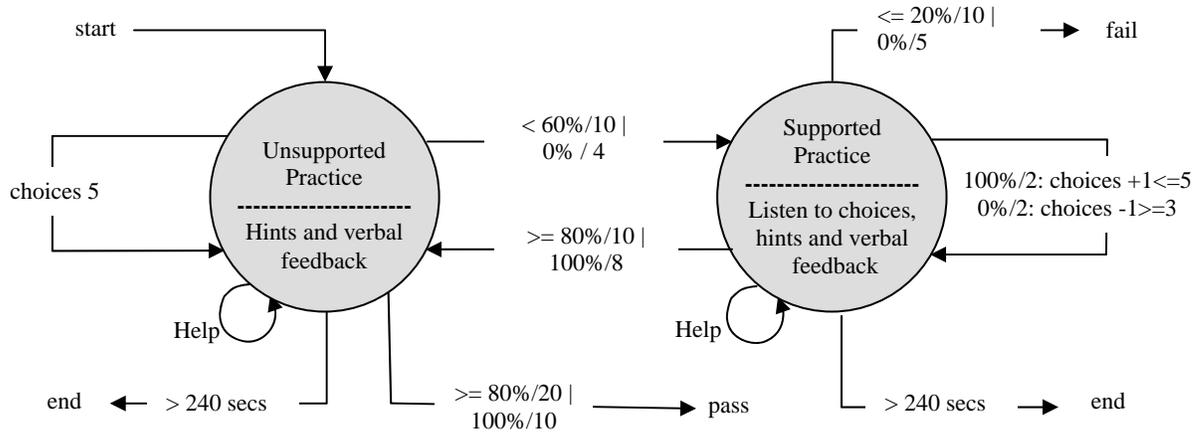


Figure 7. Performance criteria during unsupported and supported practice. Accuracy numbers listed indicate minimum and maximum thresholds in percent correct per number of consecutive items answered. (See text for explanation.)

3.1.2 Timed practice. Untimed practice is followed by timed practice (Figure 8). In addition to reinforcing automaticity, it is used to provide an assessment of student proficiency at their current working level. During timed practice no feedback other than “correct” or “incorrect” is provided and the student is expected to complete two sets in 2 minutes each. Students are only allowed one try per item. Achieving high accuracy on timed practice is not a requirement for moving to a higher level and avoids penalizing students with cognitive and other learning disabilities who may be able to answer accurately but not quickly. Appendix B lists activity-specific deviations from this description.

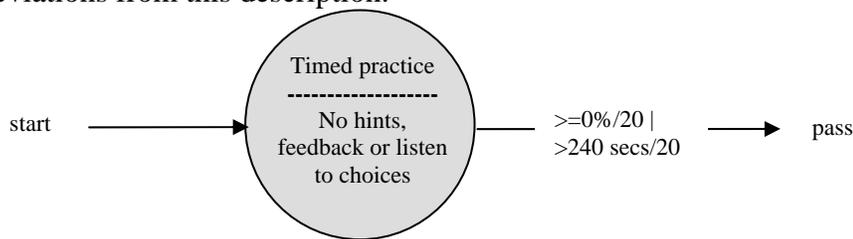


Figure 8. Performance criteria during timed test. (See text for explanation.)

3.2 Testing. Two weeks after completing a level of an activity, the activity is again presented to the student to test *retention* of the concept and skills learned previously (Figure 9). The test measures accuracy on a set of untimed items. If performing well, the student continues with current activities. If performing poorly, the student is provided additional practice at the level and activity on which she failed.

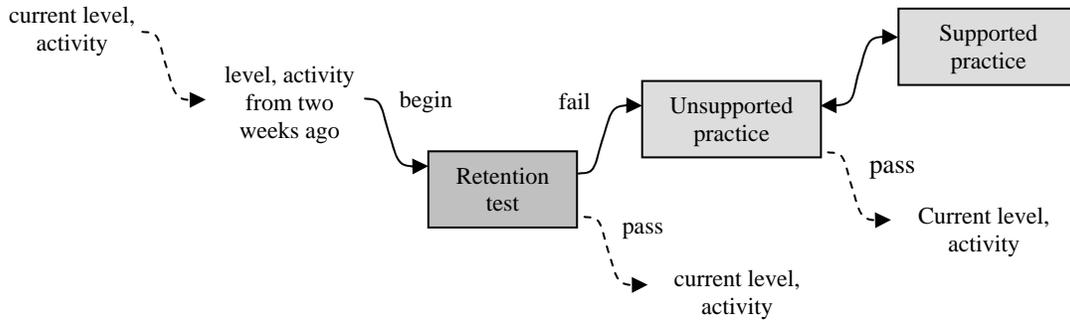


Figure 9. Testing. (See text for explanation.)

3.2.1 Retention test. The goal of the retention test is to provide an assessment of the students’ memory of recently learned skills. Retention testing activities (Figure 10) are presented as close as possible, but no sooner than two weeks after the original activity was completed and use 50% previously seen and 50% new items. The test is untimed. Only core skills activities are tested including: sound-out word reading (4 Square), sight word reading (4 Square), letter-sound identification (4 Square) and vowel finding. If the student fails a retention test (less than 70% correct in a set), additional practice is provided until the student passes with the same criteria as used during original practice.

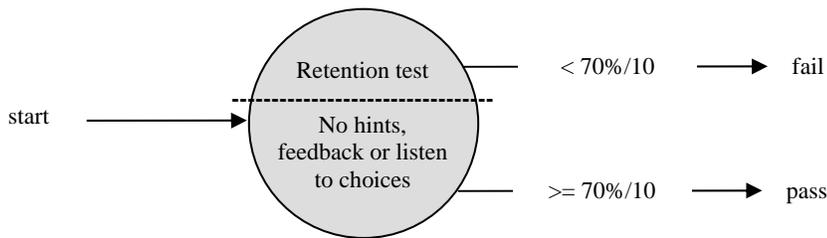


Figure 10. Performance criteria during retention test. (See text for explanation.)

4. References

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6. Disclosure

Since writing this report, the Foundations to Literacy program has been licensed by the University of Colorado to Mentor InterActive, Inc., of which Van Vuuren was a co-founder. Wise and Van Vuuren have previously consulted with the company, but are currently conducting independent research on new programs and technologies at the University. The former PI, R. Cole, left the University and is working for Mentor Interactive, Inc and started a research institute, Boulder Language Technologies, Inc, to do research independent of the University.

Appendix A

Activities ordered by module

	Activity																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Lowercase Letters	All Letters	Letter Sounds	Beginning Sounds	Middle Sounds	Begin Changing	End Changing	Ending Sounds	Sound Blending	Rhyme Changing	Beginning Blends	Vowel Finding	Regular Word Reading	Regular Word Spelling *	Sight Word Reading	Sight Word Spelling	Matching Game **
0.1	1,2	1,2															1:0
0.2	3,4	3,4	1,2														2:0
0.3	5,6	5,6	3														2:2
0.4			4,5	1-3													4:4
0.5				4-6													4:4
0.6					1	1	1,2										
0.7					2-4	2-4	3							2	4		
0.8								1-3		1-3				1-3	2	4	13:5
0.9							4,5							2	4		
1.1								4,5						3	4		
1.2									4	4			4	3	5	3	13:5
1.22									5	5			5	3	5	3	13:5
1.3										6,7		1,2	6	3	5	3	13:5
1.4													7	3	5	3	13:5
1.5												3		5	10	4	
1.6									8,9			4,5	8-11	5	10	4	13:5
1.7													12	5	10	4	13:5
1.8										10				5	10	4	
1.9										11		6,7		5	10	4	
2.1										12		8		10	10	7	
2.2											1,2			10	10	7	
2.3										13,14		9	13,14	10	10	7	13:5
2.4													15	10	10	7	13:5
2.5												10,11	16	10	10	7	13:5
2.51												12,13		10	10	7	
2.52												14	17,18	10	10	7	13:5
2.6												15,16		10	10	7	
2.8											3-5	17		10	10	7	
3														10	10	10	
4														10	10	10	
5														10	10	10	
6														10	10	10	

Levels
(with items drawn from separate list for each level)

Number of words
(with items drawn from separate list for each activity) *

Parent activity:
type (with items drawn from parent activity) **

Module 0.8
(see example below)

* The regular word spelling activity draws its items from the middle sound and vowel finding activities.
 ** The matching game activity presents content according to type, e.g. (picture, sound, text matching) and draws its items from other activities (mostly regular word reading) as listed in the table "parent activity (type)".

Example of activities, levels and teaching modes in a module

The following provides an example of activities, levels and teaching modes encountered in a typical module, demonstrating the flow within a module. The student cycles through groups of activities in each module as described earlier. For example, for module 0.8, the student will cycle through the groups of activities listed in the table below. Dependencies are shown with arrows. These indicate activities that appear as choices only after the previous activity has been completed. The student needs to complete all required levels for required activities before moving to the next module.

Module 0.8			
Group	Time (min)	Activity (* required)	Dependency sequence (Teaching mode, Level/Number)
#1	10	* Letter-sounds	R,5
		* Ending sounds	P,1→S,1 P,2→S,2 P,3→S,3
		* Rhyme changing	P,1→S,1 P,2→S,2 P,3→S,3
		* Regular word reading	P,1→S,1 P,2→S,2 P,3→S,3
#2	2	Regular word reading	M,1 M,2 M,3
#3	8	* Book reading	B,1 B,1 B,2 B,x B,x
#4	4	Book re-reading	
#5	2	* Regular word spelling	2 items
		* Sight word reading	4 items

Legend:

- P, # = Supported or unsupported practice, at level
- S, # = Timed practice, at level
- B, # = Book reading, book number
- M, # = Matching game, at level
- R, # = Retention testing, at level

In the example, the student starts with a choice of practicing Ending sounds, Rhyme changing and Regular word reading as well as a retention test of Letter-sounds, assuming this was practiced two weeks earlier. As soon as an exercise is completed, a timed version is added to the list of exercise choices, and when the Regular word reading exercise is completed, an optional matching game version is added with game play limited to 2 minutes. The student progresses through the dependency list, completing levels 1 through 3 of the exercises. After 10 minutes, the focus change from skills exercises to book reading and the student is presented with a choice of two books. After a book is read, it is placed in a library where it is available as an optional choice to be read again, up to two times and 4 minutes. After 8 minutes of reading, the student is presented with a choice of Regular word spelling and Sight word reading exercises. After 2 minutes the student continues with the initial group of exercises. In each case, the program first waits for the current exercise or task to be completed before changing between groups.

Appendix B

Activity-specific practice criteria

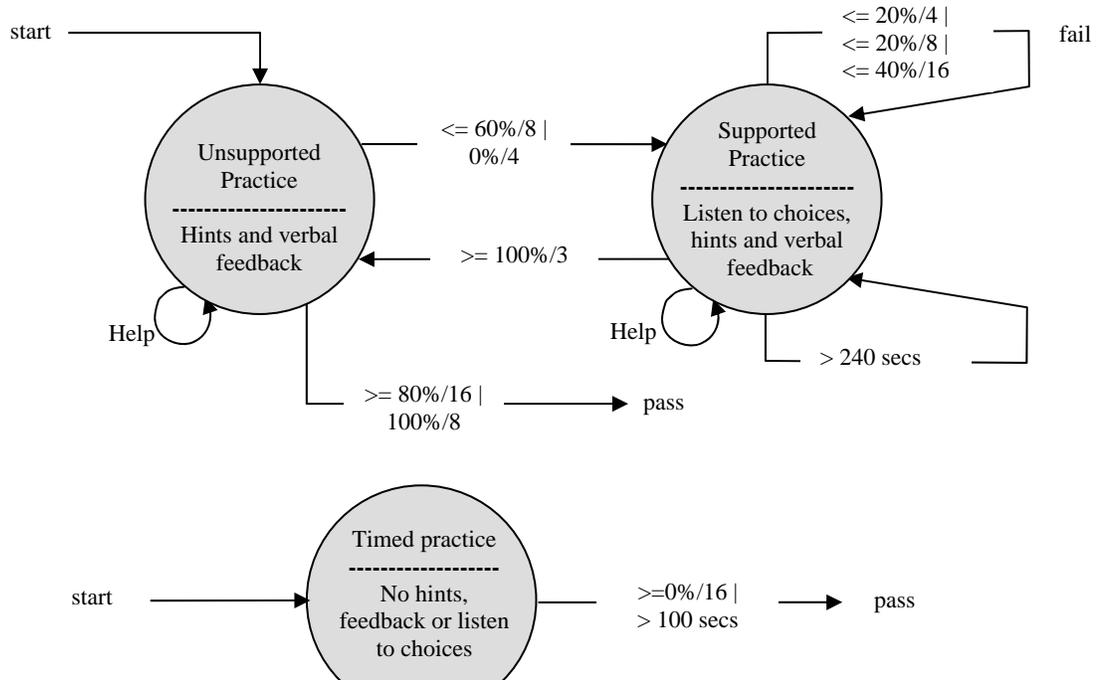


Figure. (a) Letter Matching Exercises (Rhyme change): performance criteria during practice.

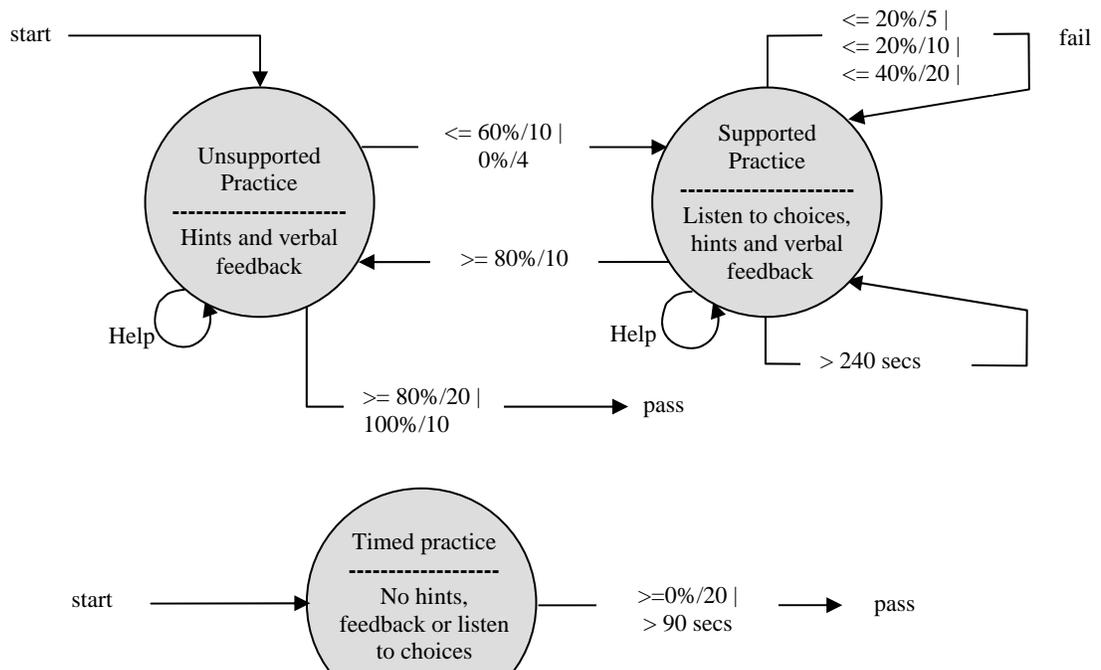


Figure. (b) Four Square Exercises (Letters, Letter-sounds, Word Reading): performance criteria during practice.

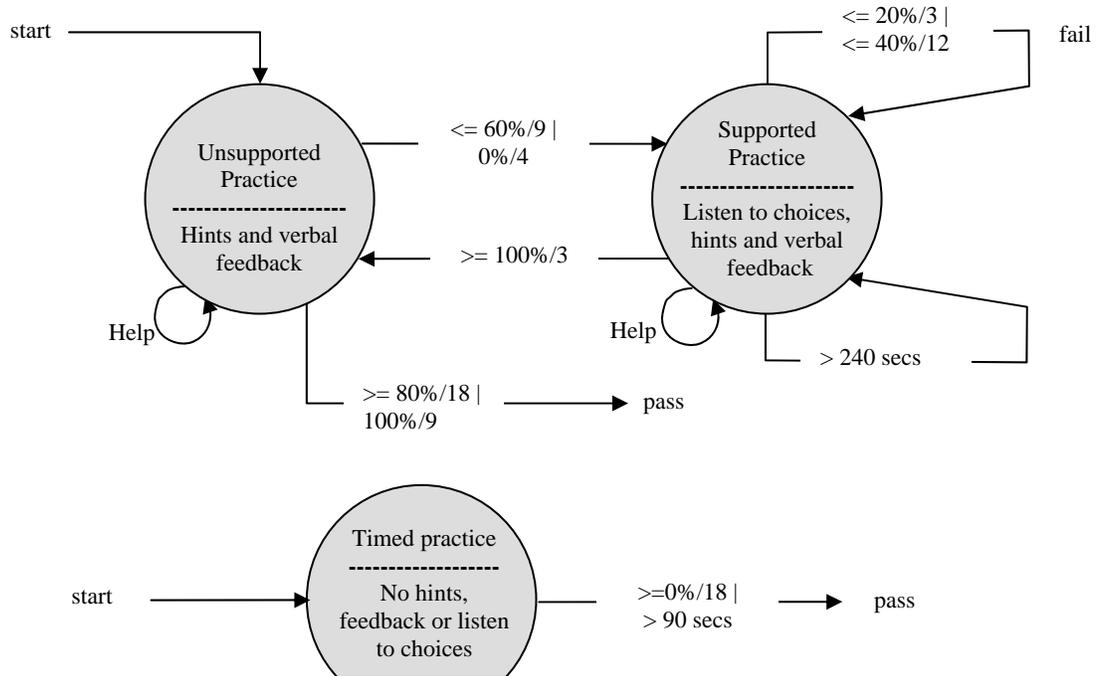


Figure. (c) Matching Word Exercises (Beginning and End Changing): performance criteria during practice.

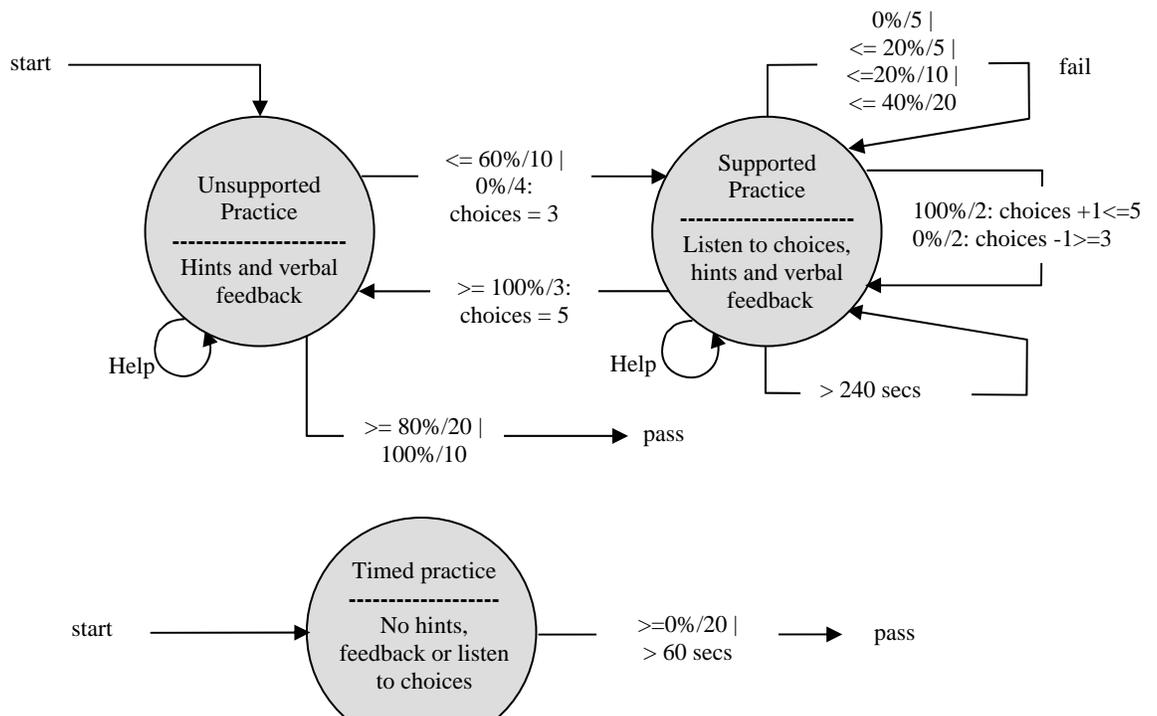


Figure. (d) Basic Exercises: performance criteria during practice.

Appendix C

Definitions

Activity. A specific task that teaches one or more skills in a particular way. E.g. find the beginning sound, change the rime, match the item, blend or segment the phonological units, find the word, spell the word, read the book.

Fail. Student does not pass an accuracy, time and/or completeness criterion for a set.

Group. Collection of similar activities for which a fixed amount of time has been allocated during each session, e.g. learning about and practicing phonemic awareness, phonics, vocabulary etc., or learning to fluently read a book and read with comprehension.

Item. A single or a multiple choice question with answer that is practiced or tested. E.g. find the word hat.

Level. A sequenced presentation of skills taught in each activity by increasing level of difficulty. E.g. man, mane; bot, boot, blot.

Module. Collection of activities that are grouped at a similar skill level in such a way as to complement, reinforce or augment a particular skill or collection of skills using activities that practice these skills in different ways.

Practice. Act of learning a new skill by answering questions while given supportive and instructional feedback. Up to three tries (answers) are allowed.

Program. The *Foundations to Literacy* reading intervention.

Session. Time spent in the program from logon to logoff.

Skill. Knowledge and ability to use a particular concept developed during training. E.g. decoding beginning sounds, digraphs, or vowel diphthongs; reading sight words; reading sentences in a leveled book or reading with comprehension.

Success. Student passes an accuracy, time and/or completeness criterion for a set.

Test. Act of assessing a skill by answering questions without feedback. Tests can be timed or untimed. Only one try is allowed.

Set. 10 similar questions or items from a level to be practiced or tested.