

“TUNEin™ to LEARNING”

...a Melodic Learning Strategy for the Classroom

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How do TUNEin™ to LEARNING products deliver *Melodic Learning* to the K12 classroom? TUNEin™ to LEARNING products are based on the methodological concepts of *Melodic Learning*. They are backed by years of field research by independent researchers. TUNEin™ to LEARNING products are used to teach a wide variety of subjects across the curriculum, ranging from basic literacy to Mandarin Chinese. This paper describes how our products comply with the requirements of *Melodic Learning*.

How are the elements of *Melodic Learning* implemented in TUNEin™ to LEARNING? This is a technical analysis. The visual, auditory, kinesthetic, rhythmic and tonal elements are integrated via an enforced protocol, which will be discussed in the next section. TUNEin™ to LEARNING products are based on a proprietary user interface that encompasses rich audio-visual content shown below.

Visual Imagery Elements

Book format lyrics are the primary textual display of the written word in TUNEin™ to LEARNING programs. Font size, lines per page and words per line are calculated via algorithms to maximize legibility for the student. These calculations become complex as the need to limit eye movement to acceptable levels competes with the demands of up-tempo melodies. Additional mathematics are applied to factor in word length in determining the visual presentation. For this reason, certain combinations of long words and fast tempos are not suitable for our products, because the eye movement required to maintain the rhythm is faster than we would like the student to muster.

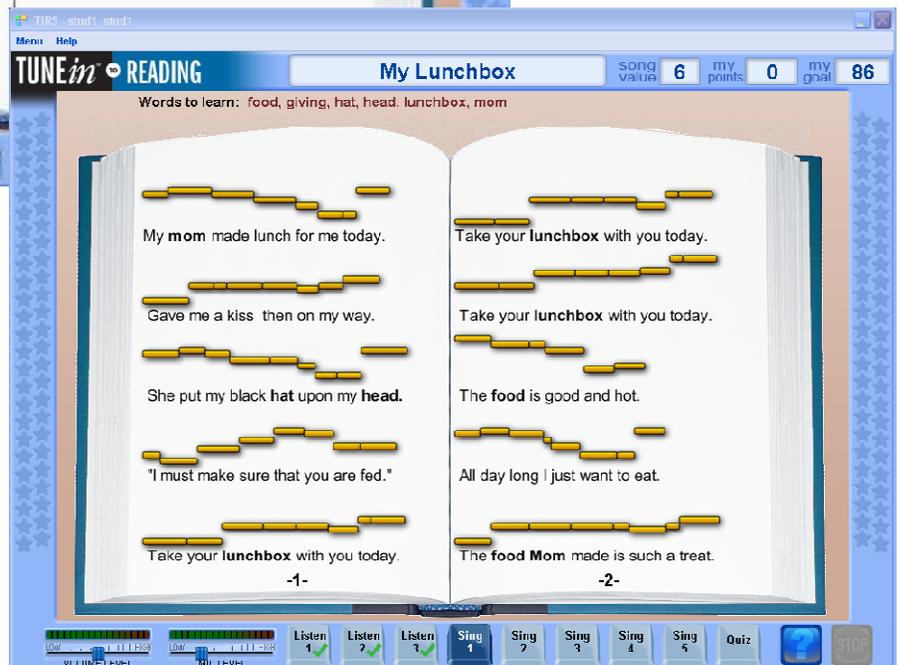
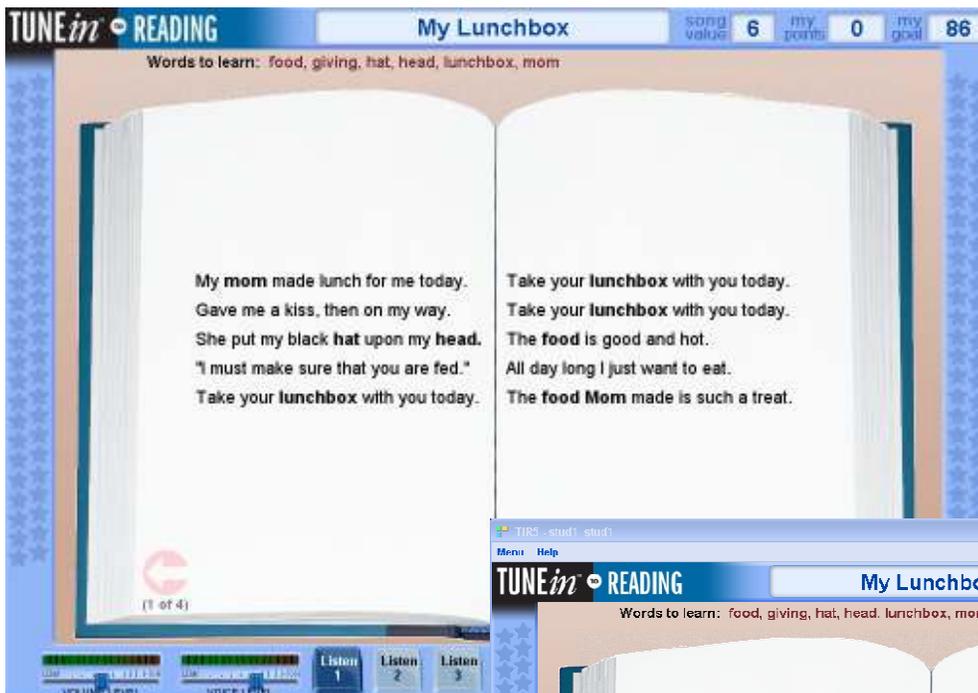
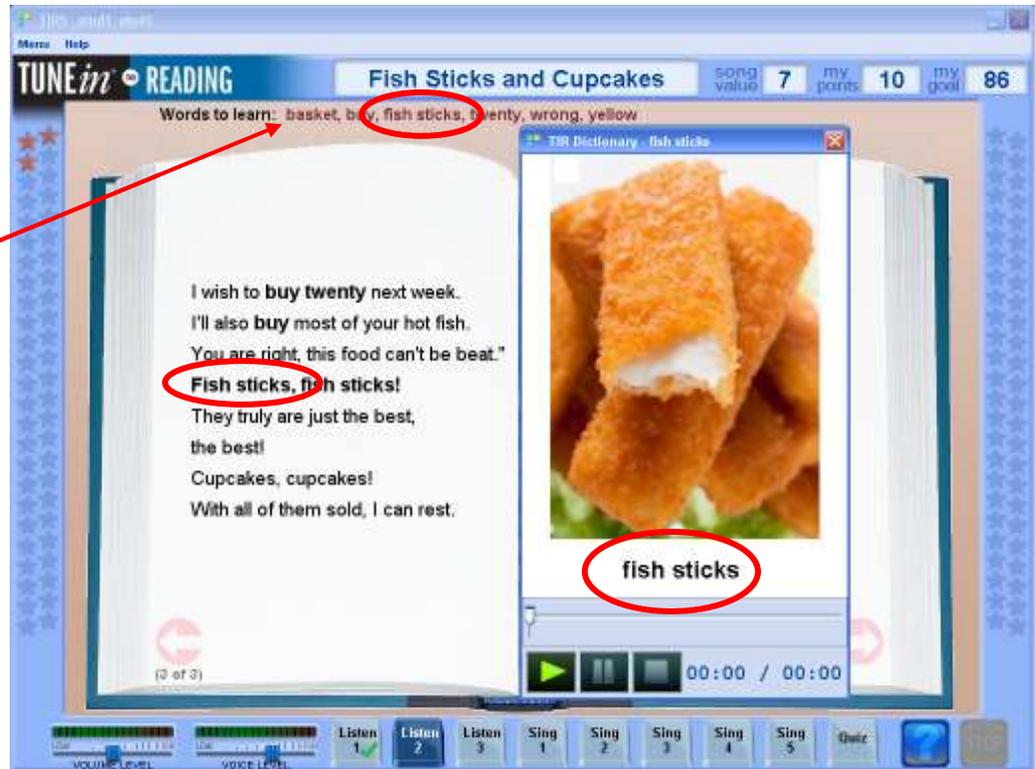


Image definitions are carefully selected by our content group in order to best aid the student with visual cues to help uncover the meaning of the “Words to Learn”. Words to learn are listed at the top of the screen, embedded in bold text within the book format lyrics. Many of these images are animations to help convey the meaning of complex words.

Words to Learn

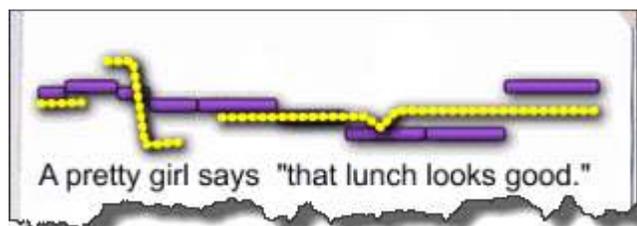
A photo and an audio definition is provided for “fish sticks”



The **Karaoke-style indicator** highlights the word or syllable that should be uttered by the student at exactly the right time and for exactly the right duration required to transmit the rhythm of the song being sung. MIDI technology underlies this functionality and our own algorithms allow us to incrementally adjust the speed of the highlighted red word in order to allow the student to gradually gain mastery of the lyrical text.



Tone/pitch tracking line – is a critical element whose purpose is to provide a visual representation of both the song’s pitch and the student’s pitch in such a way that the student can actually “see what he is singing” and develop an awareness of the pitch and tone of the song. This highly complex capability will be explained in more detail in a section unto itself. The student can see his voice in real time by the yellow pitch tracking line as shown in the image below.



Audio Elements

Native speaker recorded lyrics provide the foundation which transmits the not only the rhythm and tone of the language, but also proper pronunciation, enunciation and prosody. The songs are recorded by a variety of voices in order expose the student to a spectrum of linguistically and melodically correct renditions.

Audio voiceovers of visual images are used to integrate both visual and auditory sensory input. Our content group is responsible for selecting the right balance of number of words to overall meaning. Sometimes a one-word voiceover is the most effective way to achieve multi-sensory input for a given image. In these instances, additional wording is detractive to the learning affect. Other words require a voiceover that combines meanings from a learner’s dictionary along with the context of the song at hand.

Well established melodies are used to ensure that time tested rhythms and accompaniment will engage and motivate the student. We will speak to the emotional connection with the music in a later section. By employing well established melodies, we are reducing the risk that the chosen music does not “connect” with the student.

Proprietary lyrics are developed by our educators and lyricists to high standards. These standards include benchmarks to ensure that we are targeting approximately 80% of the high frequency words in a given grade or difficulty level, and that the songs each tell a story from beginning to end, and include a chorus to meet the repetition needs of *Melodic Learning*.

Kinesthetic Elements

TUNEin™ to LEARNING products provide a **recording studio environment**, in order to isolate the user from any ambient noise as well as nearby students engaged in sound generating activities. This provides

the student with a level of comfort and security and typically works to overcome any issues associated with a shyness to engage in the singing experience.

The tone/pitch tracking line along with the moving karaoke-style word indicator induce the need for scanning eye movements in the student and provide **visual feedback for singing experience**.

Body movements are a highly individual and context sensitive matter. It is impossible to reliably predict which songs will have a kinesthetic impact on which student. Responses range from foot tapping to head bobbing and everything in between. They are excellent demonstrations of the impact of *Melodic Learning* and a high level of engagement of the student.

Rhythmic Elements

Our musical selections leverage **well-established accompaniment** in order to maximize the engagement of the student. These selections are largely music from the public domain that has withstood the test of time, often referred to as classics. As well there are a small percentage of original compositions that are specifically designed engage the student.

Target pitch bars provide a visual experience for rhythm. These bars are unique representations of rhythm in that their vertical displacement indicates the relative pitch of the word that is highlighted compared to the other words in the song. The horizontal displacement of width of the target pitch bar is an indication of the note's duration. This patented functionality allows students with no musical background to feel the rhythm of the songs and aids them tremendously in forming a rhythmic response, thereby solidifying the *Melodic Learning* effect.

Tonal Elements

The use of a patented **real-time display of tone and pitch** makes use of state of the art mathematics including fast fourier transforms and other advanced digital signal processing. These algorithms are based on mathematics that was originally developed for the voice recognition system of the Mig fighter jet that later found its way into the private sector after the breakup of the Soviet Union. These same algorithms were later enhanced to perform at even greater speeds in order to display the tones used in spoken Mandarin Chinese and form the basis of our Mandarin products. More technical detail on this signal processing will be supplied in a later section.

Automatic vocal range detection (AVRD) is another scientific application we developed in order to synchronize the student's tonal display with the target pitch bars that have fixed position within the book view format. Think for a moment about the requirement that the vertical displacement of the target pitch bars represent the desired pitch of the notes behind each lyric. Students' voices vary dramatically in character, ranging from bass to soprano and everything in between. This would appear to make it impossible for a soprano's pitch tracking line to track to the same fixed target pitch bars as a bass. Our AVRD employs sophisticated digital signal processing (DSP) and advanced mathematics to rapidly

analyze a series of approximations in order to “know” the vocal range of the student and factor it to synchronize nicely to the vertical displacement of the target pitch bars. Thus, sopranos and basses alike enjoy an engaging and rewarding singing experience without any need to first manually determine their vocal range or to maintain it on a daily basis.

The **enforced protocol** was designed over several years in order to integrate the audio, visual, kinesthetic, rhythmic and tonal elements to achieve *Melodic Learning*. It ensures that a tested and approved scope and sequence takes place for each student regardless of their grade levels, musical ability and motivation. The enforced protocol balances the requirements of *Melodic Learning* with the need to engage and motivate the student.

The protocol must be followed in sequence and this is enforced by the application. Only the appropriate button is “enabled” allowing the student to press it to continue. The first button is “Listen 1”, which introduces the student to the song by playing the melody and accompaniment, along with a vocal recording of the lyrics by a native speaker. Listen 1 is unique because it plays the recordings at only 90% of the natural pace or tempo of the song. This is done to allow the student to become familiar with the music and the lyrics, the rhythm and tonality of the song at somewhat slower pace than normal. At the same time, it is not so slow as to embarrass or bore the student. Listen 1 engages the student in both the rhythm and tonality of the English language used in a song that has been specifically written to impart both domain knowledge as well as strategic vocabulary.

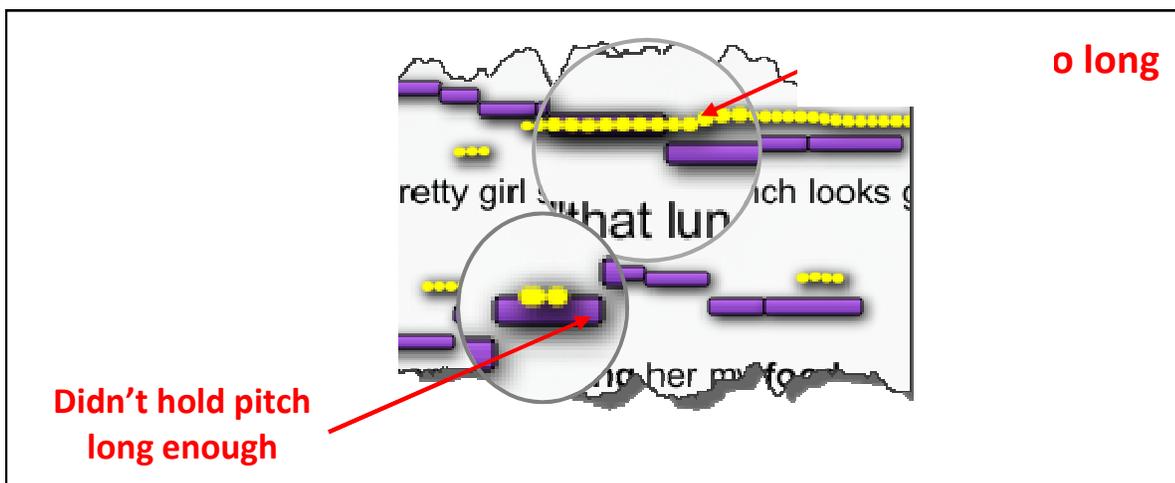
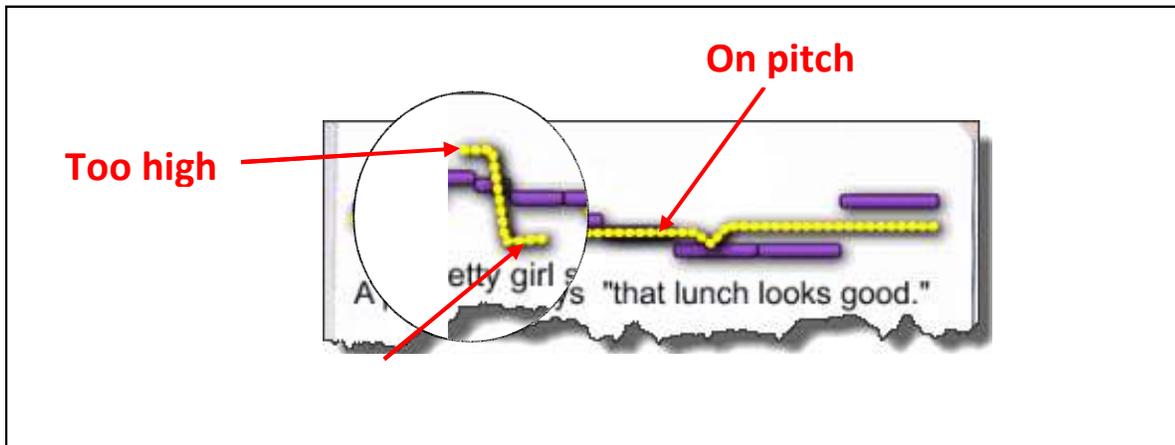


Listen 2 provides both repetition of the student hearing the lyrics sung by a native speaker and it increases the pace or tempo to normal conversational speed. The student gains familiarity and will often take the opportunity between Listen 1 and Listen 2 to “lookup” the strategic vocabulary. The student is directed to lookup the “Words to Learn” for this song before arriving at “Sing 1” in the protocol sequence. This list of words appears at the top of the screen and tracks for the student which words he has looked up and which ones have yet to be learned by changing the color from red to green. These strategic vocabulary words are in bold text within the book view format of the lyrics. Clicking on the bold vocabulary word triggers a “pop-up” multi media definition. This definition is tailored to be understandable by the student working within the grade level at hand. Sometimes these definitions can be as short as one word that combined with the picture, which may be animated, provides the optimum multi-input experience for learning.

Listen 3 is the final repetition or “warm-up” before the singing experience. In between Listen 3 and Sing 1 is the final opportunity to lookup vocabulary words. If the student attempts to begin Sing 1 without having looked up all the words to learn he will receive a message prompting him to complete his vocabulary lookups. Listen 3 is the final reinforcement of the rhythm and tonality of the language and the song prior to the singing experience.

Sing 1 through Sing 5 provide a multi-input *Melodic Learning* experience for the student. Visual cues emanate from the screen including textual lyrics, target pitch bars and a pitch tracking line. The combination of the target pitch bars with the pitch tracking line create a unique multi-input *Melodic Learning* experience for the student to receive visual cues to help them learn about rhythm and tonality.

It is an elegant biofeedback-like mechanism that enables the student to see a visual representation of what his tone should be and what rhythm he should be following. Higher bars indicate higher notes to sing and wider bars indicate longer notes to hold. This is part of the patented technology that lays the foundation for the student's *Melodic Learning* experience. As the student sings, the application paints an EKG like line superimposed on the target pitch bars. This dotted line represents the actual pitch and tonality of the student's voice while singing. As the dots rise the student is singing higher, as they fall the student is singing lower. Through this mechanism the student attempts to maneuver his pitch tracking line to fall within the target pitch bars, matching in both pitch and rhythm. See the diagram below to understand this patented technology.



Simultaneously, the well-established accompaniment plays to transmit the rhythm and melody of the language of the song at hand. Kinesthetic elements come into play when students tap their feet or move their head or body to express the beat of the music.



The **Quiz** is the progress monitoring element of the application. It displays to the student, in typical standardized test format, to provide practice and improve familiarity. The questions measure the student's knowledge of three elements:

1. Direct vocabulary - it tests for understanding of the meaning of the strategic vocabulary words precisely as they are used in the context of the song/passage that was just studied.
2. Indirect vocabulary - it tests for understanding of the strategic vocabulary in a context outside of the song/passage at hand.
3. Comprehension questions - tests the student's understanding of the meaning of the song/passage. Samples are shown below.

<<insert screenshot of three different question types, use torn pages to compact>> Ken, only have 1st grade, right? What other question types? I thought all were multiple choice...?



1. A hat is something you wear on your _____.

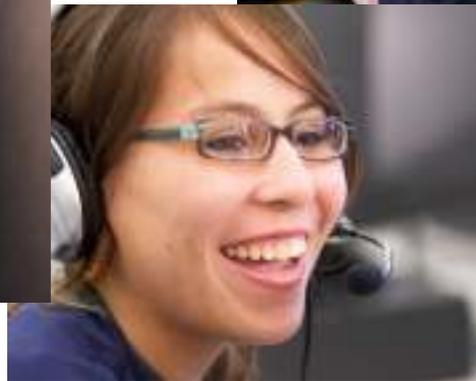
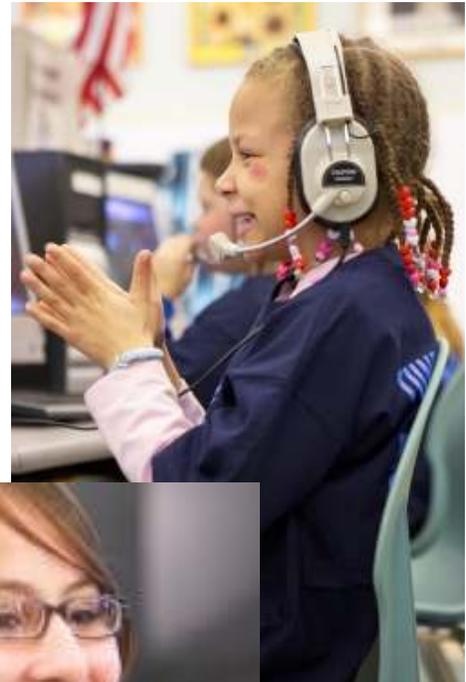
- A. foot
- B. head
- C. hand
- D. flnger



Critical Factors:

Activation of multiple senses is accomplished by the student in multiple areas. When the student looks up his strategic vocabulary, he sees both images that help explain the word along with a simultaneous voiceover. When the student is engaged in Listen 1 through Listen 3, both visual and audio cues are used to transmit the rhythm and tone of the language of the lyrics. The most complex multi-input experience is the interactive element of singing, while maneuvering the pitch tracking line to fall within the bounds of the target pitch bars.

Engagement in the TUNEin™ products can be seen in the faces of the students and the testimonials they and their teachers give. Especially for students that are struggling with learning, the part of the day when they use the TUNEin™ products is typically the most enjoyable. We know of students sneaking back into the computer lab in order to get more time using the TUNEin™ products. Below you can see some of our students along with what they are saying about our products.



"Tune in to reading was helpful because I became more confident in myself when I am reading. It made me believe in myself and be more positive."

Rachel M

"...I absolutely loved Tune in to Reading. It built fluency... It's good because it doesn't just help you, it is a fun thing to do."

Henry R.

"Tune In helped me because my reading speed really improved and during the FCAT my eyes didn't get tired."

Jennifer R.

Emotion is clearly involved when students use TUNEin™ products. Time and again they are humming or whistling some of the tunes they were singing well after they leave the classroom. Not only the music, but the meaning of the songs, often convey emotion to the students. We have noticed ESL students feel pride when working with the "immigration song". We also see middle schoolers with a devilish smile as they work through the song about teaching their parents to text! All this provides a heightened sense of engagement and emotion that is characteristic of *Melodic Learning*.

Motivation is a necessary element for any form of learning to take place. TUNEin™ students are highly motivated. In general, they love using the product. Two mechanisms are built in to ensure motivation:

1. **Rewards for “playing the singing game”.** Bear in mind that the object of the game is not to make the next Sinatra or Lady Gaga - the object is to engage and motivate the student to continue the multi input *Melodic Learning* experience... and in turn, learn. For this reason, we employ advanced mathematics and real-time digital signal processing to dampen and smooth the student’s singing to better address the positions of the target pitch bars. In other words, we are helping them appear to sing better than a strictly analytical tool of frequency measurement would. We are smoothing their curves and vocal gyrations (prevalent among male middle school students for example) so that they are not distracted by their ability to manipulate pitch, and instead are highly engaged in playing what to them seems like a game that in fact, they are pretty good at. We’ve engineered it so that even the student’s with the least rhythmic and tonal ability enjoy playing the game. They are all winners, and the application rewards every student on every song/passage with a star! The stars come in bronze, silver and gold colors for increasing ability to maneuver their pitch tracking line within the target pitch bars.
2. **Point goals.** This system is designed to create a point goal for each student. We have designed this mechanism to take into account both the amount of available computer time for the student, as well as the deficit, if any, between his physical grade level and his instructional reading level (in the case of reading intervention products). This allows us to present a goal to the student that is both attainable within the time they will be allotted, and significant in terms of learning gains. Songs/passages bear a certain number of points based on their length and difficulty. The quiz score on the song/passage determines how many of those points are added to the student’s current point total. When the student accumulates sufficient points to meet his assigned goal, the application congratulates him and the teacher prints a personalized certificate of accomplishment for him.

Repetition is the result of the motivation and engagement. Teachers do not have to encourage students to repeat exercises in order to have the desired learning outcomes. The application ensures this via the enforced protocol. If a quiz score exists for a given student on a given song/passage then there is no doubt that the student has worked his way through this song/passage through three ‘Listens’, five ‘Sings’, a quiz and several strategic vocabulary explanations.

Positive self-perception is evident in TUNEin™ student’s behavior. Teachers have been reporting this to us since the early pilot studies of 2004. Although we have not measured or tested for this explicitly, we take the word of the hundreds of teachers who have reported this to us over the years. We feel it is the expressly human nature of *Melodic Learning* that makes the learner feel good about himself. It is a natural human response.

Real World Challenges – Solved

We have a great deal of functionality that the application brings into the classroom. The next section reveals some of how this is done.

Real-time Tone/Pitch display on personal computers is a highly complex task and requires a deep background in digital signal processing and frequency measurement. These tasks are far more easily accomplished in real time when far more computing power is available than there is on a personal computer. Our software development team has benefited by technology that came available after the break-up of the former Soviet Union. Yes, we are referring to algorithms that had their start in the voice recognition systems of the Mig fighter jets that formed the basis for our real-time pitch measurement algorithms that now paint the pitch tracking line on the computer screens of thousands of school children across the country. The original signals were picked up from the Mig pilot's voice by means of a laryngophone, basically a wire strap fashioned around the pilot's neck. This wire transmitted the vibrations of the pilot's speech to computer processors inside the Mig's cockpit to in turn decode the intended navigation commands. We have enhanced these algorithms a great deal over the years and they are now capable of acting at speeds that can detect the change in tone within a single syllable of spoken Mandarin Chinese.

Rich multi-media on limited bandwidth is another technical challenge we have overcome. We have designed high speed compression algorithms to allow large multimedia files such as wave files containing native speaker renditions of songs to pass quickly down the pipe (internet) into the classroom. Our pitch and tone measurement algorithms take complete advantage of the central processing unit of the student's PC in order to reduce the bandwidth requirements to a minimum. In fact, the greatest use of the school's bandwidth occurs when a student completes a quiz. At that moment a very small packet containing the student's id, the song's id and the resulting quiz score are sent up to the hosted database. In a typical school period this might occur once or twice during a thirty minute period and this is therefore one of the secrets to our ability to provide rich experiences over the limited bandwidth typically available in a school setting.

Frequent content updates invisible to the user are made possible by our unique implementation of Java Web Start (JWS) technology. Application code as well as content updates are transmitted in a rapid and transparent manner to the student's computer. In a rapidly changing environment in which Operating Systems can receive multiple updates per month being able to respond and rapidly update our products is a great benefit to our users.

Age and grade appropriate content that meets the need is at the core of our products. Our educational consultants are responsible for creating and maintaining our song/passage library and ensuring we meet the standards of school districts across the country.

Training is down to minutes. Throughout the past five years we have made every effort to make the applications as easy as possible to use for both students and teachers. For this reason we are proud to say that student's are up and running using the application on their first day after watching a five minute video at their workstations. We do not have student's telling the teachers they do not understand what to do next because we have engineered our products so that only the correct next step can be executed. In like manner, teachers are able to learn how to setup classes and enter student data after watching a five minute video at their workstations.

Real World Results – The Proof is in the Pudding

The TUNEin™ product line was born from independent research conducted largely by the University of South Florida. It was their initial research on our music based products that brought us into the education arena and it is their research along with others that continues to drive our in TUNEin™ product line improvements.

Early pilot studies in 2004 tested the impact of our products on a small group of middle school students in central Florida. The treatment groups used our product for thirty minutes per day, three times a week, for nine weeks. While the control group showed statistically no improvement, the treatment group gained an average of more than one year's grade level from a 9-week intervention.

Expansion and replication studies came next in 2005 - 2006. The number of students studied as well as the grade levels investigated was increased in order to further validate the results of the earlier pilot studies. Again, researchers found that the average gain was more than one grade level from using the product 90 minutes per week over a 9-week period.

The Florida Department of Education, at the direction of then governor Jeb Bush, funded studies in 2006 - 2007 to understand the impact of our products on English Language Learners. In all, the D.O.E. awarded nearly half a million dollars to the University of South Florida for this purpose. The results continue to show average gains of one year, and a great deal was learned about how to improve our products for this important demographic.

In 2007 – 2008, the studies focused on upper grades in K-12 as well as Juvenile Justice sites belonging to school districts. The results across the incarcerated youth and alternative school population were also consistent with previous year's findings.

In 2008 – 2009, the focus was largely on high school students. A school just outside of Orlando, Florida served as a hub for this investigation, and the results again were strong and consistent with previous findings.

And the most recent studies in 2009 - 2010 returned the focus back to elementary schools and the impact of recent product enhancements. The results continue to be consistent since the original pilot studies in 2004. A detailed summary of these studies is shown below which includes the number of students in each study along with the results.

Overview of 6 years of research:

Study Year	School Year	Description	Grade Levels	# of Study Subjects
1	04/05	Pilot study and sustainability analysis	7 th , 8 th	46
2	05/06	Replication/expansion	5 th , 8 th , 11 th	252
3	06/07	English language learners Title 1 elementary level	6 th 3 rd , 4 th , 5 th	79 302
4	07/08	4 elementary schools 2 Boys & Girls Clubs 1 rural high school 8 Juvenile Justice sites	4 th , 5 th 9 th , 10 th , 11 th	393
5	08/09	1 elementary school 1 high school	4 th , 5 th 10 th	78 110
6	09/10	1 elementary school, 1 high school	4 th , 5 th 9 th	120 26
Total Study Subjects:				1406

Detailed abstracts of the individual studies are available at:

<http://www.tuneintoreading.com/Our-Research-Base>

Conclusion

In summary, the in TUNEin™ product line accomplishes its mission of delivering *Melodic Learning* to the K12 classroom, thanks to its advanced design and patented technology. The result is improved and more permanent learning across the curriculum for students of all backgrounds, and particularly for students who have not been able to learn via more traditional methods.