THE MAGIC SCHOOLHOUSE

SBIR INNOVATION PROPOSAL

Mark Loparco

PROJECT NARRATIVE – TECHNICAL CONTENT

1. SIGNIFICANCE

A. PROBLEM AND POTENTIAL

> *A child's world is fresh and new and beautiful, full of wonder and excitement. It is our misfortune that for most of us that clear-eyed vision, that true instinct for what is beautiful and awe-inspiring, is dimmed and even lost before we reach adulthood. If I had influence with the good fairy, who is supposed to preside over the christening of all children, I should ask that her gift to each child in the world be a sense of wonder so indestructible that it would last throughout life.*
>
> Rachel Carson, "The Sense of Wonder"

> *The child is endowed with unknown powers, which can guide us to a radiant future. If what we really want is a new world, then education must take as its aim the development of these hidden possibilities.*
>
> Maria Montessori, "The Absorbent Mind"

"Powers and possibilities," it's true, and yet every ten seconds, a student in the United States drops out of high school. For this now *former* student, the future is anything but radiant. Instead and more likely, it is a future dimmed with shadows and darkness, a future likely filled with a sad catalog of unfortunate realities:

- Children out of wedlock
- Malnourishment and obesity
- Reduced lifetime earnings
- Victims of violent crime
- Incarceration and prison
- Depression
- Disease
- Early death

The causes for dropping out are many and multifaceted, including:

- A concern for personal safety
- The need to support the family
- Peer pressure to drop out
- Involvement with gangs
- Falling behind academically
- The loss of motivation and interest

What is rarely documented or discussed, and what precedes, far precedes, the dropping out of high school is something more difficult to discern or quantify, something more elusive and insidious: *The loss of wonder. Wonder. That feeling of admiration and amazement when encountering the beautiful and new.* We are all born with it, from the infant first discovering her toes to the kindergartner first transforming black squiggles on paper to *meaning*.

If not protected and guarded like the fragile flame it is, this sense of wonder will shrink, shrivel and blow away, buffeted by the difficulties and vicissitudes of life. For what obstacles to wonder must exist for a child walking the streets of a long neglected neighborhood or the halls of a decaying school? Whose home environment long ago abandoned any true sense of magic? For that child to keep alive *wonder*, she would need to be forged of heroic stuff – and more than likely, her teachers as well. For it takes a heroic

effort to overcome, on a daily basis, settings that cry, or even just whisper, of *want*. Of the want of the *safe*, of the want of the *supportive*, of the want of the *wonderful*.

This proposal then makes a case for *the wonderful*. Through the use of an unprecedented and magical technology called "augmented reality," we aim to amplify *wonder* in schools, and through *wonder*, initiate a causal chain of improvements that lead ultimately to more students graduating from high school, thereby placing them back on the path to the radiant future that is their birthright as citizens of the United States of America.

And *"The Magic Schoolhouse"™* is our vision of how this will happen.

B. The product, its Implementation, and the Intended Outcomes

Introducing *"The Magic Schoolhouse"™*

It has often been remarked that an ancient time traveler, if transported to the inside of a present-day classroom, would find little unchanged from the classroom of yore. Desks would still be arranged in neat rows pointing forward; heavy textbooks would still strain the desks and backs of the children; the teacher would (happily) still be teaching, though imparting knowledge from up front, the all-knowing "sage on the stage."

Imagine now that this traveler lands instead inside *"The Magic Schoolhouse,"™* a place unlike anything ever encountered. Upon his arrival, he is bestowed with a most curious device – a mobile tablet powered by augmented reality (AR) technology. AR is an unprecedented technology resulting from a moment-in-history confluence of individual digital technologies like the camera, GPS, compass, accelerometer, touch, audio and wireless (to name a few). Coordinating these technologies through intelligent software applications, AR can for the first time overlay the physical world with dynamic digital content, effectively creating a "human intelligence layer" that covers the world.

It is the closest thing to magic that we have yet seen in the digital era. And to our friend the time traveler, the tablet becomes a "magic lens" revealing never-before-seen marvels:

On the walls:
- A Times Square "Jumbotron" displays student-created artwork
- An animated cuckoo clock sings out the time *a capella*
- Posters of sheet music come alive with actual music
- A news ticker scrolls teacher-approved "News of the Day"
- A video "talking head" of the teacher annotates items in the room

On the floor:
- An alphabet rug teaches phonetics and reading
- A spinnable globe highlights the countries of the world
- A scale map of the United States shows the shapes of all fifty states
- Three-dimensional models display architectural and national landmarks
- An interactive roller-coaster teaches acceleration and physics

On the desks:
- A metronome keeps time to the music
- Animated "popup" books bring stories to life
- A translator translates words from one language to another
- A virtual microscope reveals amoeba and paramecium
- Three-dimensional models display Platonic and Archimedean solids

On the children:
- Wigs adorn their heads, worn by the Founding Fathers (and Mothers!)
- Augmented T-shirts display personalized content
- Halloween masks that use facial recognition and tracking
- A pirate's parrot stands on their shoulders
- Harry Potter's "Sorting Hat" jabbers away

On the ceiling:
- A three-dimensional solar system revolves 'round the Sun
- Animated weather reveals cloud formations and real-time weather data
- A helicopter flies around the room, chased by fire-charged dragons
- A game of Sudoku appears on the tiles, as well as checkers and chess and... Parcheesi
- A view of the "Horsehead Nebula" appears as the ceiling dissolves away

A classroom transformed. The schoolhouse made magic. *Wonder* rekindled:

The ceiling dissolves, revealing the "Horsehead Nebula" above

Implementation, Resources and Feasibility

"The Magic Schoolhouse"™ is a suite of mobile applications for teachers and students designed to amplify *wonder* in schools. It requires the following main components:

- A mobile tablet
- An Internet connection (for the teacher)
- *The Magic Schoolhouse* application
- A laser or inkjet printer
- Paper image targets

The mobile tablet would be typically either of the Apple iPad (iOS) or Google Android variety. The tablets would be installed with *The Magic Schoolhouse* application, which can be installed either by synchronizing with a desktop application like iTunes™ or by downloading directly to the tablet via a wireless connection.

It is important to note that a wireless connection is not needed. This will facilitate the accessibility of the product and allow students to use the application securely without needing access to the Internet. All required content (e.g., Jumbotron) would reside on the tablet. For those classrooms that have a wireless connection, additional live content like weather and news feeds could be brought in, further enriching the experience.

Teachers would need to print out "image targets," patterns that the tablet recognizes and overlays with digital content. The image targets would be downloaded from *The Magic Schoolhouse* website and printed on a standard black-and-white printer. The image targets would be placed around the classroom and used as triggers for the augmented experience.

In addition to using pre-made image targets, the application could be programmed to recognize custom artwork created by the students. In this way, a student's drawing of Mount Rushmore could become the catalyst for displaying an actual three-dimensional model. This personalization will greatly add to the level of student engagement, which is important for the long-term success of the product, and most importantly, the student.

In its initial implementation, *The Magic Schoolhouse* would provide all of the interactive three-dimensional content required by the teacher and student, curated and pre-screened for age-appropriateness. The content would consist of:

- Two-dimensional images and animations (e.g., maps)
- Three-dimensional models and animations (e.g., architectural models)
- Dynamic content (e.g., weather, which requires an Internet connection)

Intended Outcomes

Through its goal of infusing the classroom with *wonder*, *The Magic Schoolhouse* is intended to lead to long-term measurable improvements in the rates of student graduation. There is a direct causal link on how this will be achieved, which is discussed in the next section.

C. THE THEORY OF CHANGE, AND THEORETICAL AND EMPIRICAL SUPPORT

Theory of Change

The following diagram illustrates the underlying "Theory of Change" that guides and motivates the design of *The Magic Schoolhouse*:
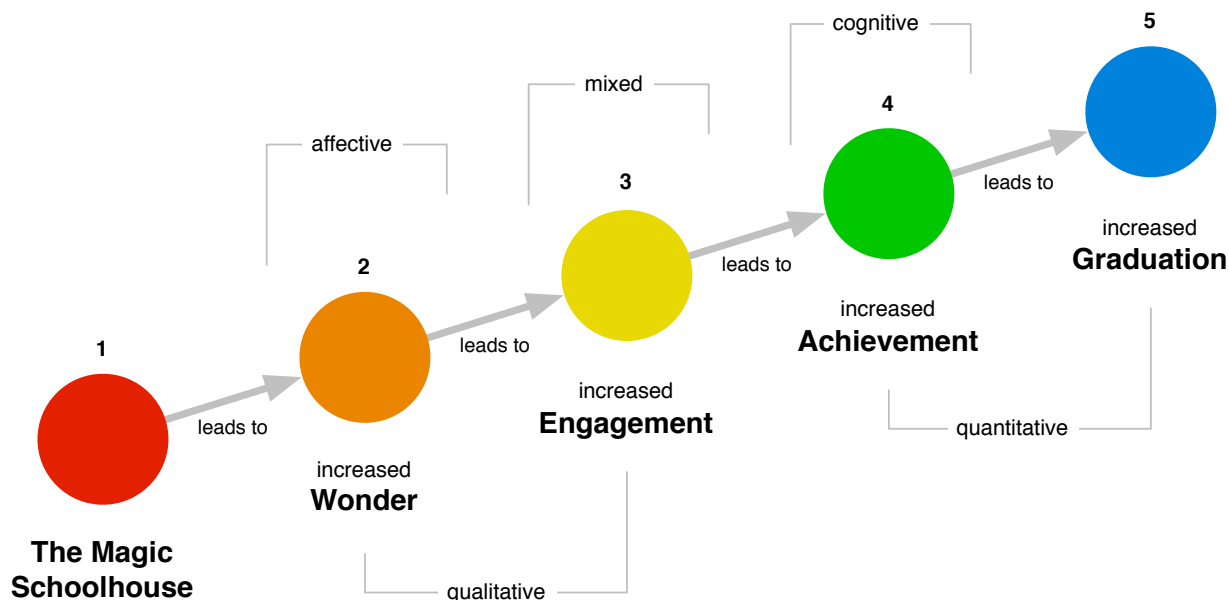
As the model illustrates, the Theory of Change's causal chain progresses in a positive upward direction from the first step of encountering *The Magic Schoolhouse* to the final step and ultimate outcome of *increased Graduation*. In summary:

- *The Magic Schoolhouse* leads to increased **Wonder**
- Increased *Wonder* leads to increased **Engagement**
- Increased *Engagement* leads to increased **Achievement**, and
- Increased *Achievement* leads to increased **Graduation**, which is the ultimate long-term intended outcome of the project.

Note that both *Wonder* and *Engagement* are primarily **qualitative** in nature while *Achievement* and *Graduation* are more **quantitative**. In addition, there is an associated progression from the **affective** to the **cognitive** domains as one ascends toward increased *Graduation*, with *Engagement* falling squarely in the center of the model. *Engagement* thus holds a position of prominence in the model, of which more will be discussed.

This progression can be used to guide the design of the learning content itself, whereby the initial encounters with the content build *emotional* connections and capabilities, and subsequent encounters emphasize the more *cognitive* and *quantitative*.

The following pages discuss each step in the Theory of Change in detail.

Step 1. *The Magic Schoolhouse*

The first step on the upward path to increased *Graduation* is the encounter with *The Magic Schoolhouse* itself. As the path's very first step, *The Magic Schoolhouse* serves as the portal to a new way of experiencing school, a way that facilitates *Wonder* at every level. Thus every detail of *The Magic Schoolhouse* will be designed for its potential to support *Wonder*.

Among the core design criteria guiding *The Magic Schoolhouse*:
- Extreme ease-of-use – to facilitate *adoption*
- High degree of interactivity – to encourage deep *engagement*
- Dynamic and personalized content – to keep the experience *fresh*
- Multi-leveled humor – because teachers need to *laugh* too!
- Whimsy and novelty – to introduce the power of *surprise*

The notion of "novelty" merits further examination. As Madison Avenue knows all too well, that which is *novel* has tremendous power to capture our attention. This can be used both for good and ill. For our purposes, "attention" is a key prerequisite to learning and as such is central to our approach. As discussed in Wittrock's "Generative Model of Learning," you must first capture a person's attention before you can teach him or her anything.

An issue with novelty arises when the novel turns staidly familiar. At some point this familiarity, if not breeding contempt, will at least breed indifference and possibly outright annoyance, which are the absolute antitheses of wonder. Thus a key design criterion is how to keep things perpetually novel and fresh. The key lies with *personalized content*.

As the creators of such widely trafficked sites as YouTube and Instagram know well, to remain fresh and relevant you must have users provide their own personalized content. The world is just too vast for anyone, even behemoths like Google and Facebook, to create enough original content to satisfy their customers. This reality was first posited by Alan Toffler in his now prophetic book "The Third Wave" in which he introduces the concept of the "prosumer" – a new-on-the-scene entity that is both *producer* and *consumer* of content. Without the prosumer, YouTube and Instagram could not exist.

Thus a key principle in the design of *The Magic Schoolhouse* is that students will be afforded a mechanism by which to integrate and display their own content. This will keep the experience both new and highly personalized. Seen this way, *The Magic Schoolhouse* becomes not only a content provider but a content manager that facilitates the integration and display of third-party, student- and teacher-generated content.

Imagine again then, the virtual Jumbotron in the classroom, capable of displaying both teacher-curated and student-supplied content. Modeled, programmed and hosted by *The Magic Schoolhouse*, this Jumbotron becomes the dynamic canvas upon which a literally endless amount of always-new content can be displayed.

This freshness will facilitate that continuous sense of *Wonder* essential to student success.

Step 2. Increased *Wonder*

We have spoken much about *Wonder*. As the only element in the model that *The Magic Schoolhouse* can in fact *directly* affect, *Wonder* holds a position of high importance. What then are the elements of *Wonder* that *The Magic Schoolhouse* can target?

According to Descartes, Hobbes and Smith, *Wonder* is primarily an *emotion*, engendered by related positive emotions like *Joy*, *Surprise* and *Admiration*. Interestingly, and important for our purposes, is their converse observation that *Wonder* is diminished by a corresponding negative emotion: *Fear*. Fear has many dimensions, among them fear of the *new*, fear of the *unknown*, fear of the *complex*.

And fear has no place in the classroom. So *The Magic Schoolhouse* will be designed to be a safe place where *Wonder* is fostered and safeguarded from fear. Content will be friendly and age-appropriate; user interfaces will be intuitive and easy to navigate; deployment will be managed and sensitive to the rhythms and needs of the classroom.

An additional challenge to *Wonder* is *measurement*. As Krakauer posits:

> *How do you search for words and numbers to convey the force of a revelatory phenomenon and to capture a quantifiable change brought about by this new keenness? How do you measure the value of transformation? What is the color of insight? What kind of yardstick could measure the intensity of my exhausted astonishment standing in the wake of wonder?*

Like an unseen planet revolving a distant star, or a sunken pebble that just caused a ripple, *Wonder* may best be measured only indirectly, by the *effects* that it causes. And as our Theory of Change contends, the effects of *increased Wonder* are *increased Engagement*, which is readily measurable. And so it is now to *Engagement* that we turn our attention.

Step 3. Increased *Engagement*

As our Theory of Change illustrates, *Engagement* is positioned squarely in the center of the model, residing in both the affective and cognitive domains, affording both qualitative and quantitative methods of assessment. Engagement can thus be thought of as something akin to a mathematical function, a virtual "black box" that converts inputs to outputs – in this case taking *Wonder* as an input and converting it to *Achievement*:

Wonder ⟶ **Engagement** ⟶ **Achievement**
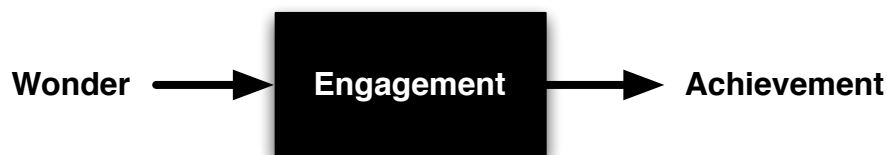
For such alchemy to occur, clearly something special must be going on inside that box. What is it about *Engagement* specifically that allows such transmutation to occur?

According to Csikszentmihalyi, *Engagement* lies at the heart of the "flow" state – that happy state that we have all been in where space and time seem to melt away. Where hours pass easily, creativity pours effortlessly, and happiness and satisfaction *ensue*. That sacred state where we become imbued with the fulfillment of our own potential.

The extraordinary thing about flow is that it actually encompasses all three elements of *Wonder*, *Engagement* and *Achievement*, representing an all-encompassing *dynamic process* in which inputs and outputs flow bidirectionally between the three parts:
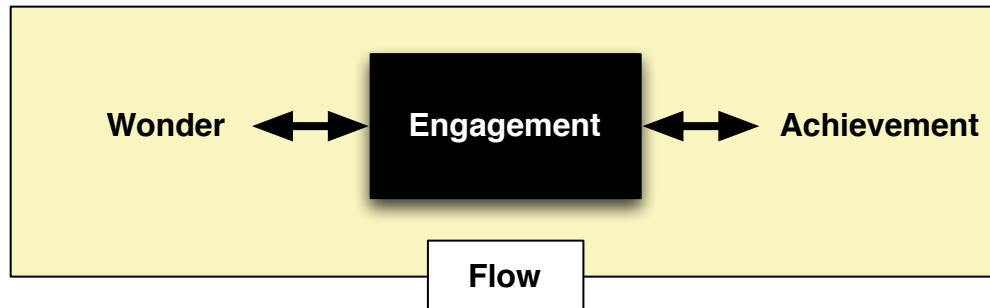
And so how does one measure *Engagement*? Through both traditionally observable behaviors like time-on-task as well as more recent methodologies that emphasize the emotional and affective. According to the IES study "Measuring student engagement in upper elementary through high school," there are 21 instruments for measuring *Engagement*, including:

- Motivation and Engagement Scale (MES)
- Student Engagement Instrument (SEI)
- Engagement versus Disaffection with Learning (EVSD)
- Motivated Strategies for Learning Questionnaire (MSLQ)

Rather than invent a 22nd instrument, we will likely apply one or more of the existing instruments to our study, allowing us to focus on the user experience.

And the IES study says more, to the point, that there is a *positive correlation* between student *Engagement* and student *Achievement*:

> *Student engagement measures have been shown to correlate positively with achievement and negatively with the likelihood of dropping out of school (Fredricks, Blumenfeld, and Paris 2004). Engaged students are more likely to earn better grades and perform well on standardized tests (Fredricks, Blumenfeld, and Paris 2004; Marks 2000).*

This is consistent with our Theory of Change, which contends that *increased Engagement* leads to *increased Achievement*. And so it is now to *Achievement* that we turn.

Step 4. Increased *Achievement*

In educational settings, *Achievement* is the most measurable and measured of goods. From homework to quizzes to tests, from GPAs to AYPs to SATs, virtually everything seems to have a number attached. There are cognitive measures like "questions answered correctly" and affective ones like "plays well with others." For that is how it must be, for we must somehow know "how we're doing."

But beyond the numbers, there looms the larger question of what it actually means to "achieve" in our larger society? Is it measured by the square footage of one's house or the decimals in one's bank account or the firmness of one's Sleep Number bed? Or is it something else, something more, something deeper?

For a place like *The Magic Schoolhouse*, a place that seeks to engender *Wonder* above all, a new measure of *Achievement* is needed, one that measures not only a student's success at consuming content but also her contributions to the whole *wonder-filled* enterprise. Can we tally up *laughs* like Monsters, Inc., lighting up a classroom as they did a city? And can a student help others experience *Wonder*, and in the process engender such feelings herself?

As our Theory of Change presupposes and as reality bears out, *increased Achievement* not only leads to *increased Graduation,* but is in fact a *requisite* of it. And so it is now to *Graduation* that we turn our final attention.

Step 5. Increased *Graduation*

As near to a "rite of passage" as we have in our pluralistic society, *High School Graduation* marks a definite and irrevocable milestone, a distinct fork-in-the-road separating the radiant and dimmed paths, dividing a nation where no division need be.

And unlike the *Wonder* upon which it may very well rest, *Graduation* is unequivocally *measurable*. And the measures so far tell the tale: a student lost every 10 seconds, 8300 lost every day. President Obama framed it well in his first address to Congress in 2009:

> *In a global economy where the most valuable skill you can sell is your knowledge, a good education is no longer just a pathway to opportunity – it is a pre-requisite. And dropping out of high school is no longer an option. It's not just quitting on yourself, it's quitting on your country – and this country needs and values the talents of every American.*

And so we forge on, believing that every student has within him or her great powers and possibilities. And the capacity to *Wonder*, which may in the end be what saves us all.

D. Related R/R&D by the Project Team

The principal investigator has been integrally involved in the design and production of software for over twenty years, from educational software for Knowledge Adventure (makers of *MathBlaster™* and *KidCAD™*), to "edutainment" software for game companies like Activision (makers of *Muppet Treasure Island™* and *Call of Duty™*) and Disney (makers of virtually everything else!), to mission-critical software systems for both the business and national defense communities, including the Department of Defense.

Related educational software products

For every client in every industry, there has always been an emphasis on both *innovation* and *usability*. The product must be innovative to take advantage of the latest technologies and presentation techniques, while being highly usable to maximize user productivity and efficiency, particularly in a military setting. There is a considerable experience with a wide range of user personas, from kindergarten children to Air Force fighter pilots.

In fact, the principles employed in designing user interfaces for children are directly transferable to those needed in a high-intensity, mission-critical environment like a military command center – both require interfaces that are intuitive, unambiguous and that facilitate attention. With children, attention spans are limited – the software must be accessible and engaging enough to maintain attention. With military users in a 24/7 command center, sensory overload and fatigue become central issues – auxiliary items should be hidden until needed, and colors and contrast must help keep users alert.

Regarding augmented reality, the same design principles apply – the content must be readily accessible, intuitive and engaging. In several pilot interactions with children in which three-dimensional content magically appeared over an image target, the inherent "wow" factor created instant engagement while touch-centered interactions sustained it.

E. Similar Products or Typical Practices

As discussed, AR is a truly unprecedented technology. As a result, the opportunity exists to establish standards and best practices, which *The Magic Schoolhouse* intends to do. To date, most of AR's applications and demonstrations have appeared in commercial settings like retail stores and trade shows. From popup three-dimensional Lego™ sets on kiosks to rotating Volkswagens™ at car shows, most applications have been designed with the explicit goal of increasing the chances of selling the user a *product*.

Commercial uses of Augmented Reality

Since commerce often drives innovation, this is all well and good, especially if we can apply learnings from commerce to the realm of education. For instance, studies have shown that augmented reality increases the quality and duration of a user's engagement with the content. For retailers, this heightened engagement has been shown to be directly proportional to increased sales – that is, a customer holding an augmented Lego set where the pirate ship comes alive is more likely to buy the product than one merely holding the box. This is a source of hope for those designing educational content.

In a retail setting with a high rate of customer turnover, the "wow" effect is maximized and easily maintained for the duration of the visit. For other settings like schools where the turnover is not nearly as rapid, there runs the risk of suffering from "the novelty effect" where something compelling at first glance turns uninteresting with time.

As discussed in our Theory of Change, for *wonder* to be sustained, the novelty effect must be mitigated by the introduction of dynamic user-generated content. This again forms a central design principle to which *The Magic Schoolhouse* will repeatedly adhere.

F. POTENTIAL COMMERCIAL APPLICATION

In its initial implementation, *The Magic Schoolhouse* will be at its core a software application running on mobile tablets. As such, it will be sold through traditional software channels like the Apple App Store and Google Play Store. The initial application will come with a core set of "augmentations" for users to experience the vision of the product, allowing them to experience the "wow" moment of seeing their classroom transformed.

Additional augmentations will be available for sale either as individual "in-app" purchases or as bundled thematic "packages" like STEM, Language or Music. For example, a STEM package might include science-oriented content like a three-dimensional Periodic Table. Language packages might include "translator" functionality and a dictionary of the foreign language in question. Music packages might include content that brings sheet music to life.

For all content types, there are three complementary paths to commercialization:
1. Original IP – Create original content and sell on the respective app stores
2. Partnership – Augment existing content like textbooks and educational posters
3. Subscription – Offer a subscription service to host and share user-generated content

2. PHASE I TECHNICAL OBJECTIVES

A. PHASE I R/R&D OBJECTIVES

Phase I will focus on creating a compelling user experience deployable within the classroom environment. The technology objectives will thus be in the following areas:

Performance of AR Engines – The choice of AR engine is extremely important to the long-term success of the project. Some engines emphasize rapid image recognition while others focus on location-based features like GPS. Since most content is 3D, OpenGL rendering speed is essential to the user experience and so will be an area of evaluation.

Markerless Tracking – Markerless tracking enables a richer user experience, as it does not require the user to lock on an image to trigger the augmentation. Using "point-cloud" technology that builds a three-dimensional map of the environment, markerless tracking is a powerful feature that is becoming available in several AR engines.

System for Personalized Content – Since student-generated personalized content is central to student engagement, we will be architecting a system for seamlessly integrating this content, including uploading to a cloud-based server as required. Because of privacy concerns, we will also be evaluating behind-the-firewall solutions for each school.

Ergonomics of Classroom Deployment – Since augmented reality is an unprecedented experience in school settings, its deployment must be carefully managed. We will be testing the usability of the application throughout the period of performance, using this formative evaluation to continually refine the content and user experience.

B. PROJECT PERIOD

The project objectives will be scoped for the allotted 6-month period of performance. The following timeline and discussion outline the primary tasks during this period:
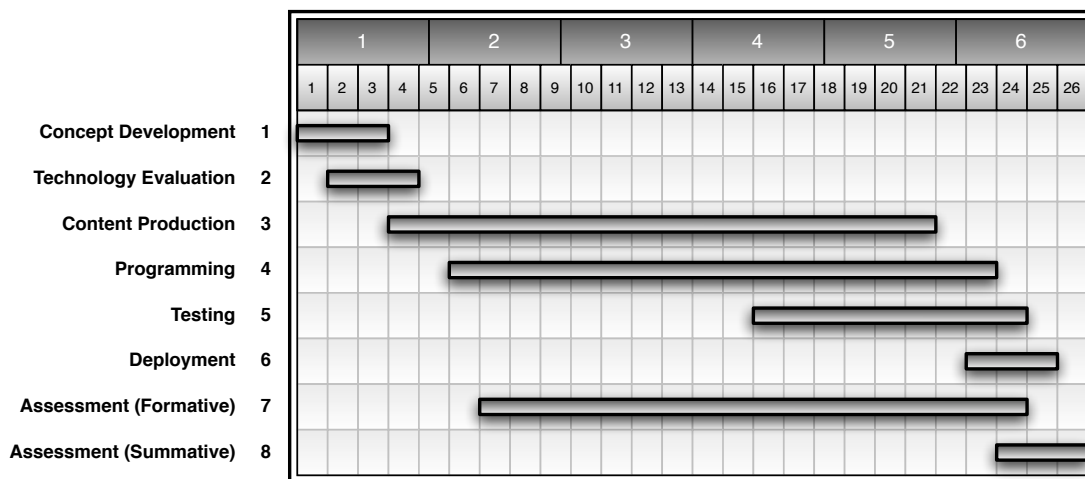
Phase I Timeline

The primary activities for each task are as follows:

#	Task	Duration	Primary Activities
1	Concept Development	3 weeks	• Refine concept scope to fit the period of performance • Get stakeholder (teacher, parent, student) buy-in
2	Technology Evaluation	3 weeks	• Evaluate AR Engines (Qualcomm, Metaio, Unity, etc.) • Evaluate server-side technologies (PHP, .NET, Java)
3	Content Production	18 weeks	• Produce three-dimensional content (static & animated) • Produce paper-based and e-book support materials
4	Programming	18 weeks	• Program in Unity Game Engine (cross-platform) • Program server-side components as required
5	Testing	9 weeks	• Alpha testing throughout to test usability • Beta testing at end to facilitate deployment
6	Deployment	3 weeks	• Both tablet-based and server-side deployment • Teacher support for classroom deployment
7	Formative Assessment	18 weeks	• Formative Assessment throughout • Iterate into Content Creation and Programming
8	Summative Assessment	3 weeks	• Assess lessons learned, best practices moving forward • Writing of final report

3. PHASE I WORK PLAN

A. DEVELOPMENT OF THE PROTOTYPE

The prototype will be developed in stages, beginning with the initial proof-of-concept to verify that students have accepted the basic premises of the experience, namely that an augmented experience can be understood and can engender feelings of *wonder*. The concept will be continually refined to create maximum excitement and engagement.

A range of augmentations will be created, covering all surfaces in the classroom (ceilings, walls, floors, etc.) as outlined earlier. Feedback will focus on which surfaces and which content types are most successful.

As proprietary content is being developed, we will focus on student-generated content and evaluate for engagement levels. It is our hope and hypothesis that this will add an entirely new dimension to the experience.

B. RESEARCH ON THE USABILITY OF THE PROTOTYPE AND THE INITIAL FEASIBILITY OF THE CONCEPT

The initial prototype will likely be deployed in a public school fifth-grade classroom in Oak Park, California. The teacher is highly comfortable with technology, including serving as a "21st Century Teacher" on the leading edge of technology implementation. The school is well equipped with technology, including having a high volume of iPads.

The children are also highly technically literate, many of them having iPads or computers at home. Though the demographic is relatively atypical, this allows us to evaluate the actual augmented experience without getting diverted with technology issues.

Of the research questions we will ask and hopefully answer:

- How intensely are the students engaged in the activities?
- Do any performance issues exist with the technology?
- Are there any usability issues with the application?
- What are the ergonomics of the classroom?
- What is the relationship between the teacher and students?
- Are there any opportunities for collaboration between the students?
- What are the teacher's and students' impressions of the experience?

C. POTENTIAL PROBLEMS

This is a disruptive vision. It aims to enliven the status quo and re-infuse classrooms with a sense of *Wonder*. Infectious and uncontainable, *Wonder* can bring with it a host of "unintended consequences," including such sights as:

- Children highly engaged, impervious to school bells or instructions
- Chuckles and guffaws as they watch dragons fly around the classroom
- Children lying on the floor as they look up through the ceiling to the stars

And so deployment must be carefully managed during select times of the day. It will be essential to work closely with the teacher, ensuring that she is both comfortable with the technology and capable of handling this new addition to her classroom.

4. PROJECT TEAM – Biographical Summary of Each Key Project Personnel

Mark Loparco - Principal Investigator

From *Kermit the Frog* to *Mickey Mouse*, Mark Loparco has collaborated with some of the most beloved names in family entertainment. Mark started out as an architect, graduating from Cornell University with a Bachelor of Architecture, and after receiving his M.A. in Education from UCLA, spent several years creating educational software for children.

As an architect, technologist and educator, Mark has been able to combine these diverse interests in the creation of a wide range of products for a diverse set of clients, including the *Common Core* backbone for the Bill & Melinda Gates Foundation and award-winning command centers for the U.S. Department of Defense.

Most recently, Mark has been working in a research and development environment on mission-critical software systems, with an emphasis on user experience. Much of what he has learned can be directly transferable to the design of *The Magic Schoolhouse*.

Mark lives in the Los Angeles area with his wife and two children, who are his first beta testers for his many proofs-of-concept.

5. RESOURCES

The technology resources required to implement Phase I of *The Magic Schoolhouse* are readily available and so make the project extremely feasible. Primary resources include:

- Augmented Reality Engine (e.g., Vuforia, Metaio, String, D-Fusion)
- Application Development Environment (e.g., Unity, XCode)
- Content Creation Tools (e.g., Sketchup, Maya, Google Warehouse, Adobe CS)
- Server Hosting (e.g., Amazon Elastic Cloud, Rackspace)
- Tablet Devices (e.g., iPad, Nexus)

Augmented Reality Engine – The AR Engine would normally be the most cost- and time-prohibitive element in the system, yet because many are either open-source or available for moderate licensing, we can leverage the countless person years that went into their development and use their sophisticated computer vision algorithms in our application.

Application Development Environment – The "Unity Game Engine" will likely be used to develop the actual mobile application. Unity can deploy to both iOS and Android, as well as game consoles like Wii and Playstation. In addition, Unity uses a plug-in architecture that eases the integration of many AR engines.

Content Creation – Original 3D content will likely be created using either Sketchup (for static content) and Maya (for animated content), two of the most popular and powerful 3D creation tools. In addition, thousands of pre-made 3D objects (e.g., Mount Rushmore, Solar System) are available for free on Google's 3D Warehouse.

Server Hosting – We will likely use cloud hosting by Amazon or Rackspace to deploy the server-side components of the application. This allows us to pay for only the time used rather than a continuous meter. In addition, these systems are extremely scalable when the time comes to deploy to a wider audience.

6. COST BREAKDOWN/PROPOSED BUDGET

Please refer to Appendix E.

7. HUMAN SUBJECTS

Please refer to Appendix F.

8. SIMILAR OR CLOSELY RELATED AWARDS OR PROPOSALS

Not Applicable.

9. DOCUMENTATION AND STATUS OF PRIOR SBIR PHASE II AWARDS

Not Applicable.

REFERENCES

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