Adapting the Flipped Classroom for At-Risk Science Students through Learner-Centered Design

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Abstract:

One goal of this project is to create a collection of Learner-Centered videos to meet the needs and provide learning opportunities for alternative education students. Video creation and delivery will be based on the Learner-Centered Design principles and concepts adapted from the Flipped Classroom and tailored to the needs of at-risk students within my school. Another very important goal of this project includes creating production guidelines and a teacher self-evaluation process guided by Learner-Centered Design and the Flipped Classroom. These guidelines will be useful for developing effective videos and helpful for other teachers who want to use similar teaching techniques for alternative education students.

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Introduction

In today's environment of high stakes testing students and teachers are being held more and more accountable for the information learned in class. Lack of engagement in students is a major hurdle for most teachers. I teach in an alternative education school where these challenges are amplified by the nature of the student body. Students in an alternative education setting are often even more at risk for disengagement and thus academic failure. New ways to reach high school students in and out of the classroom are beneficial not only to the students but also for the teachers.

Alternative education schools serve students with a variety of needs. Many students are already considered to be at-risk for dropping out and have withdrawn from school by showing poor attendance and little effort. Other students are teenage parents, are expecting a child, or are unable to attend school regularly due to the needs of their families. Some students have behavioral problems. They are too violent or disruptive to remain in regular programming at their home schools. Sometimes students go directly into alternative education from juvenile lock-up facilities; the alternative education school is intended to provide a transition between the facility and the mainstream school. Students often have minimal parental support and many families have other struggles and therefore do not promote education as a priority. All students encounter barriers while learning, but those barriers tend to be more concentrated among the alternative education population.

The mission of alternative programs is to provide a different type of instruction to help students become engaged in education again or to find a way to navigate the obstacles that are currently in their way. Class size is ideally limited to 15 students to

enable teachers to give more attention to each student (Johns, 2013). Flexibility within curriculum and assignments is necessary in order to allow students to complete work they miss due to absences or while missing class due to disciplinary action. Scaffolding course content so that students can build connections to prior knowledge is essential to meaningful learning and it is one of the biggest challenges with poor student attendance. It is difficult to move forward with content as a class when so many students miss lessons on a regular basis. Sometimes students are placed in a self-paced after school program or an at-home tutoring program due to behavior difficulties or maternity leave. In order to stay on track and continue moving toward graduation, these students need to keep up with curriculum with only the help of a tutor who may not have expertise in all subject areas.

Many of the obstacles faced by alternative education students make it hard to participate in classroom discussions, activities, presentations or videos that augment the learning process. Students who are not in the classroom, regardless of the reason, miss out on many educational experiences. According to classroom data, Living Environment students enrolled in the alternative education school Middle Settlement Academy had an average attendance percentage of 49% as of December 20, 2013. It is difficult as a teacher to take the time in class to try and recreate these experiences while still moving forward with the other students. It is nearly impossible to bring these experiences to the students who are working from home or in an after school programming. Due to these circumstances, students are constantly working on a variety of different assignments within the room which can be very difficult to balance as a teacher. This is why the

asynchronous nature of video learning is appealing for use in the alternative education setting.

In comparison to other areas such as agriculture and industry, the methods used for teaching have remained relatively unchanged since the Renaissance (Koller, 2011). In many ways, efficiency has not increased with implementation of new technologies in the same way that it has in other areas. Despite being considered one of the most developed countries in the world, with plentiful access to technology, the United States ranks 20th for high school completion rate (Koller, 2011). Countries that outperform the United States include Slovenia, Portugal, Japan, Finland, and the United Kingdom. In addition, the graduation rate in the United States falls below the entire European average as well as the overall average of countries studied by the Organization for Economic Co-operation and Development (Cardoza, 2012). Innovative teachers are using technology in new ways with great results, but these changes are the exception rather than the rule. As a teacher of primarily at-risk students, I believe integrating video technology as a supplemental learning tool has the potential to help bridge some of the learning gaps caused by poor attendance. Due to the correlation between attendance and achievement (Ziegler, 1972) which tends to work against at-risk students, I hope that by properly addressing this issue flipped classrooms can also help to increase motivation, understanding, course completion, and Regents test scores.

Video creation technology is becoming more and more user friendly and has a lot of potential for use in and out of the classroom. Videos have evolved from the times of film reels and video cassettes and can be created with very little equipment and extra time. Now that video technology has become affordable and easy to use, anyone can

create and transmit videos in a variety of ways. Teachers can make videos, slide shows, and narrated notes in video format to allow students to view asynchronously or outside of the classroom.

As video production has been simplified over the years, many teachers are using video in traditional and non-traditional ways. One model that has been gaining attention is referred to as the Flipped Classroom. In a Flipped Classroom, students are expected to watch short video lessons on their own at home, and their time in class is spent working with the teacher on what would traditionally be assigned as homework (Borgman, et al. 2013). Although some adaptation would be necessary as at-risk students have very low participation on all homework assignments, this idea appeals to me for the alternative education setting. Students could catch up on lectures and lessons, or watch short videos of classroom activities independently after missing class. This would help them to catch up to their peers. Students who work at home or in after school programming would also have the opportunity to get some teacher instruction as well. The videos would also be available for students to re-watch when they are struggling with a concept or need to review for an exam.

One goal of this project is to create a collection of Learner-Centered videos to meet the needs and provide learning opportunities for alternative education students. Video creation and delivery will be based on the Learner-Centered Design principles and concepts adapted from the Flipped Classroom and tailored to the needs of at-risk students within my school. Another very important goal of this project includes creating production guidelines and a teacher self-evaluation process guided by Learner-Centered Design and the Flipped Classroom. These guidelines will be useful for developing

effective videos and helpful for other teachers who want to use similar teaching techniques for alternative education students.

Research Questions:

How can Learner-Centered Design and the Flipped Classroom help influence the creation of effective learning tools for alternative education students?

Learner-Centered Design dictates that prior to creating new materials for the classroom it is important to understand your students and their needs. A multitude of questions exist regarding how video can be best tailored to at-risk science students. Length of video, amount and complexity of content, and method for video creation must all be taken into consideration. Review of literature and Learner-Centered Design will guide the video production process.

A variety of tools exist to create video material. Equipment ranges from a cell phone camera to high tech and high cost video equipment. Schools will not readily purchase new equipment because of budget constraints and the personal purchase of expensive tools may be unrealistic for many teachers. Also, computer software in many schools, including my own is not always up to date, so videos must not exist only in a format that is difficult to use for older computers. Most teachers have limited time for planning and classroom preparation. This time is also used for meetings, parent conferences, grading, and working on the ever increasing demands of the New York State Common Core requirements and demands of the new evaluation systems. In order to integrate video into the classroom on a regular basis, a method that is realistic for easy everyday use must be determined. My goal is to determine how to create useable material for the students in a way that is cost effective, of reasonable quality, and can be created in a time efficient manner so that any teacher can attain a similar goal.

How can the Flipped Classroom methodology be adapted to alternative education science students?

According to Learner-Centered Design and the Flipped Classroom, what methods of presentation/delivery of video learning tools might create the most successful outcomes for alternative education students? Another difficult question is: How I can best present this new video material to alternative education students? Video can be broadcast on the Internet, on cell phones, on personal computers in the classroom, and a variety of other methods. Alternative education students have unique needs regarding behavior, motivation, and attendance and I want to know what will work for these students. How can this process be streamlined to ensure that all resources are high quality, while providing guidelines that might help other teachers create useful videos as well? Research of other teacher experiences, video creation and self-evaluation, as well as feedback from colleagues will be used to help resolve this issue.

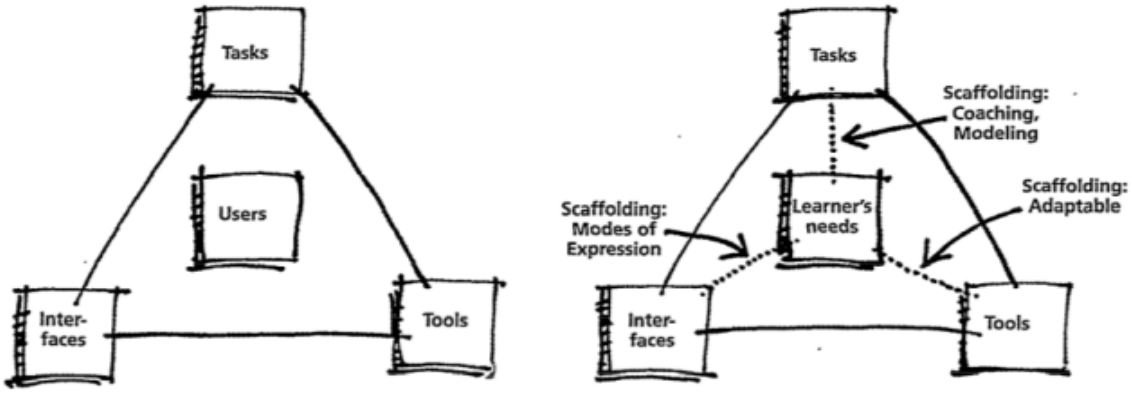
Literature Review:

Learner-Centered Design: What is it?

Learner-Centered Design is a method of information design intended to help tailor learning systems to those who are using them to learn. Learner-Centered design is considered the educational equivalent of the Human-Centered or User-Centered Design approaches that are well known and often applied to the development and creation of business tools (Zaharias & Poulymenakou, 2006). As the use of web technologies for learning continue to increase, a need for design methods specifically for online learning tools is becoming more necessary as well. Learner-Centered Design takes the perspective of the learner into consideration during the design process of creating usable web materials much like Human-Centered Design, but also recognizes the many differences between "users" and "learners." Users, as recognized by Human-Centered Design are considered to already have an existing knowledge base regarding the systems that they will be using. The intent of Human-Centered Design is to help design a useable interface to efficiently complete a task which the user is already familiar with. With Human-Centered Design, the goal is not to learn new information, but to use a new interface efficiently. Learners on the other hand are considered to be novices taking in new information for the first time (Quintana et al, 2001). For this reason, the needs of learners are somewhat more complex than those of users and more factors need to be considered when incorporating Learner-Centered Design. Learner-Centered Design demands that materials designed are not only usable, but also create the ideal environment for learning new information (Zaharias & Poulymenakou, 2006). Figure 1 below, from Learner-Centered Design: The Challenge for HCL in the 21st Century,

depicts why developers of Learner-Centered Design suggest that simply applying Human-Centered Design to learning technology as is not enough (Soloway et al, 1994, p. 6).

Figure 1: Human-Centered Design vs. Learner-Centered Design



Source: Learner-Centered Design: The Challenge for HCL in the 21st Century. 1994.

Learner-Centered Design focuses on the target audience in order to create usable learning material. Learner-Centered Design has been adapted around the ways in which learners differ from the users described in User-Centered Design (Quintana et al, 2001). Learners, unlike users, are generally a very heterogeneous group. They typically do not share a common culture, background, or understanding of the material being presented. Learning happens when a learner takes new information and makes connections to things that he or she already knows, and the variety of differences in background as well as skill level can making designing good learning tools a difficult process. Learners may also lack the motivation that drives users (Quintana et al, 2001). Users are often motivated intrinsically to use these tools for their own convenience or they are motivated extrinsically to use the tools as a requirement of a job. Learners on the other hand are

expected to have an intrinsic desire to learn in order to achieve their diploma and improve their futures, but this is often too abstract for learners to take seriously. Experiencing difficulties in learning can lead to increased lack of motivation, so skill level, learning styles, and potential frustrations for the learner as well as the usability of the new materials must all be taken into account during the design process.

The basic goal of Learner-Centered Design is to know the needs of the learners and design a product that will allow them to learn. The needs of the learners include both their needs as learners, as well as how they will need to utilize the information being learned. For example, in science class, students do not simply need to memorize facts; they also need to be able to apply that information to multi-step questions on the New York State Regents in order to graduate. Because motivation can sometimes be an obstacle for learners, the materials designed would ideally initiate a desire to learn as well as presenting the tools needed to learn new information (Soloway et al, 1994). Soloway et al also stated four important pieces of information that must be incorporated in Learner-Centered design: 1- understanding is the goal for learners, 2 - motivation is the basis, 3 - diversity of learners is the norm, and 4 - learners' growth is the challenge. This aligns perfectly with the challenges facing teachers in regular face-to-face classrooms everywhere; therefore it is logical that the design methods for the creation of an online educational tool would encompass the same set of needs.

Learner-Centered Design: Applying it to Alternative Education Science Students:

According to the New York State Common Core Curriculum and graduation requirements, all students must pass the Living Environment Regents with at least a 65%

in order to graduate. Achieving the required grade of 65% is a big obstacle for many at-risk students. In June 2013, 34 alternative education students from an alternative education school in central New York took the NYS Living Environment Regents, and only 10 of those students passed with a 65% or higher. That 29% passing rate is slightly lower than previous years due to recent changes brought about by the New York State Common Core Curriculum. However, it is not very far from the typical Regents results which have been between 35-50% over the last 8 years. In order to qualify to take the Regents examination, students must meet the minimum requirement of successfully completing 1200 minutes of laboratory activities, which means many students were not even eligible to take the examination. The learning technology developed in this project is intended to eventually be a resource that helps students understand science content to the degree where they are able to apply it to laboratory activities and successfully answer questions on the New York State Living Environment Regents.

The initial step of Learner-Centered Design is to understand the needs of the learner. In the case of alternative education students, the needs vary. Many behavior problems are avoidance tactics for students who struggle with learning. Many students are socially promoted throughout elementary and middle school, and end up in high school with very limited reading capabilities. Other students come into the school as ELL or English Language Learners. These students vary from barely speaking English to nearly fluent. Other students have individualized education plans because of specific difficulties in certain areas of learning, often reading or the ability to focus on material. At the beginning of the 2013-2014 school year, alternative education students at the aforementioned school in central New York took a computerized literacy test called

STAR Reading. The test was able to gauge each student's IRL or Instructional Reading Level which is the highest reading level at which a student is 80% proficient at comprehending material with assistance and thus the level at which learning would be optimal. The average Instructional Reading Level of the 10th graders at this school is 5.4, which translates to a fifth grade reading level. Students in 9th grade have an average of 4.5, which translates to a fourth grade reading level. These students are constantly being asked to use materials designed for reading levels 9 and 10 which frequently leads to increased frustration.

Motivation among learners is improved by an appealing and engaging appearance (Spitulnik, 1995). Showing learners how information can be useful for dealing with real world tasks is also a helpful motivational tool (Norman & Spohrer, 1996). The intention for motivating students would be to allow them to explore information, build new ideas, and interact rather than passively observe a lecture or read text. The videos alone will not be interactive, but it is essential to include some interaction or exploration in order to make the experience more meaningful. Students may engage in written or verbal dialogue with a teacher or another student, or there could be an Internet research component as a follow up to the video.

Diversity of learners can be addressed by teaching to different learning styles and learning abilities (Spitulnik, 1995). This is especially important in an alternative education classroom where learning styles and ability levels vary greatly. As mentioned previously, it is very common for alternative education students to have skill levels below where they should be for their ages and grades. The independent nature of watching a video will help make each student's experience unique. Dialogue with the teacher or

completion of a written follow-up assignment could lead to very different experiences and feedback depending on the current knowledge level of the student. Some students will begin by simply trying to understand and remember concepts being taught whereas other higher level students may observe connections to other outside information. Another way that the videos will help address diversity among learners is that information will be presented visually, with written text and also spoken word. This combination appeals to multiple intelligences and can help build reading fluency while obtaining new information.

The Flipped Classroom:

As with most new educational ideas, the Flipped Classroom has been met with a variety of results and opinions. Many sing praises for the way the Flipped Classroom has freed valuable classroom time for teacher-student interaction, higher level discussion, and application of newly learned knowledge. Others feel that the method is simply another way of delivering a very old learning method: the traditional lecture (Horn, 2013). The latter of the two groups believe that because this is essentially the same lecture that has always existed, unmotivated students will remain unmotivated despite the new learning arrangement.

Positive aspects of the Flipped Classroom:

The Flipped Classroom model was designed out of necessity by teachers. It was intended as a method to help students who had been absent catch up with missed lessons. The teachers realized however, that students who had not missed class were watching the videos as well to help reinforce classroom lessons. This brought about the idea to assign

videos at home to teach concepts, and free up class time for class discussion and help with assignments (Tucker, 2012).

In 2010, a study by the Department of Education stated that online learning is as effective as learning in a classroom, and that a combination of learning online and in person is shown to be the most effective (Koller, 2011). Most current high school students have had access to the internet since they were born and are considered to be "digital natives." Many enjoy posting and watching videos online with ease and frequency that impresses a typical adult, which makes learning through video a logical way to reach these students.

Allowing time for students to learn and process new information on their own leads to the asking of better question and promotes an increase in independent thinking (Tucker, 2012). This arrangement has also flipped the way a teacher's attention is divided in the classroom. In a typical classroom, the students who answer questions and interact with the teacher most are the ones who are engaged and understand the material while struggling students may hesitate or disengage altogether. In a flipped classroom, the more advanced students have the freedom to move ahead independently while the teacher can focus extra time helping students who need additional explanation (Tucker, 2012, p.82).

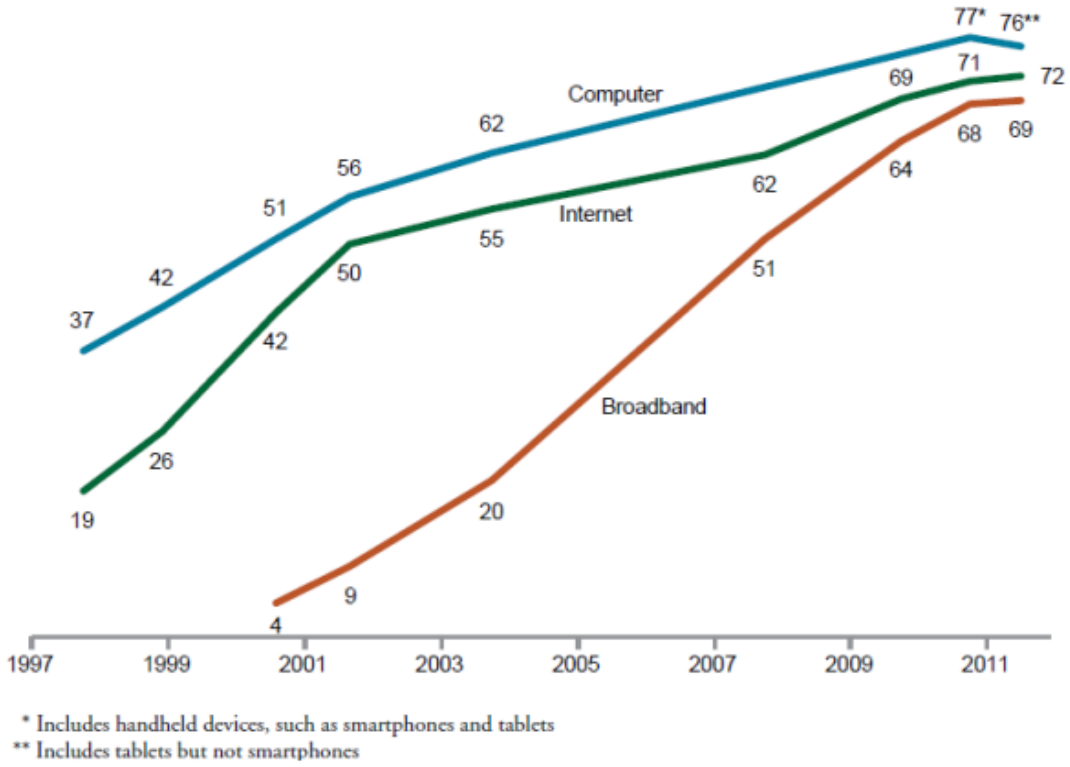
The Flipped Classroom approach can help close the learning gap between students who come from educationally supportive and non-supportive families. Students with supportive families can receive help and motivation from their parents in regards to homework assignments and projects. On the other hand, many students come from

homes with a lower socioeconomic status or where there is a cultural barrier preventing good communication between the school and the family. This missing link between home and school can unfortunately have a negative impact on a student's education (Smith, 2006, p.49). The flipped model has potential to allow all students to begin learning content at home and all students will receive the same level of support with assignments and projects in class because that support is coming directly from the teacher (Ash, 2012).

Negative reviews of the Flipped Classroom:

The positive aspects of the Flipped Classroom outlined above represent great potential for new methods of learning. Unfortunately, realistically, it is only achievable in the most perfect of circumstances. Approximately 97% of households in the United States live in areas where broadband internet services are accessible, however according to Exploring the Digital Nation (2013) only 69% of households actually had a broadband internet connection as of 2011 (72% if you include households with dial-up). This number is growing consistently (see Figure 2 below), and is very promising, but it is not currently helpful in schools with a disproportionate number of students living in poverty.

Figure 2: Internet Use in Households



* Includes handheld devices, such as smartphones and tablets
** Includes tablets but not smartphones

Source: Overview of Household Adoption Rates by Technology, Percent of U.S. Households 1997-2011, "Exploring the Digital Nation," 2013.

Some feel that the Flipped Classroom is simply a new way of using a very old instructional method: the lecture (Ash, 2012). Assigned learning at home, and discussion in the classroom has been common practice for years and the Flipped Classroom is simply a new method for the same practice. Students cannot simply watch a quick video as homework. Some level of thinking or interaction whether it is writing notes or coming to class with a question is necessary for the full effect (Tucker, 2012). The important part of making a flipped classroom successful is the role of the teacher and his or her ability to engage the student in the video watching activity and in the classroom activities that build off of the video. Learner-Centered design shares this perspective so it

is evident that the student-teacher interactions before and after the video is a key piece to learning.

In one case study a college professor provided narrated, pen-based online videos demonstrating the use of mathematical formulas as a voluntary study material for students in an introductory college course. Students stated that the online materials were helpful, but fewer than 25% of students accessed the materials before exams. In addition, the number of students who accessed the online materials declined as the semester progressed and the test scores of those who used the materials did not differ significantly from those who did not (Melhorn et al, 2011).

How the Flipped Classroom method can influence an alternative education classroom:

Educators agree that there is no single method for flipping a classroom. Teachers can assign videos as homework, allow class time for watching videos, or create videos for the voluntary use of students without attaching an assignment to them at all (Ash, 2012). The flexibility of this tool allows for the adaptation to a variety of educational circumstances.

More and more homes, even in lower socio-economic schools, are getting access to computers and the internet. Many students have access to video technology streaming through their smart-phones. Some students may be able to access videos during school hours or in a library. Finding alternatives for students who do not have internet access such as burning DVDs or creating a list of places where students can go online for free is a good way to make these resources universally available to students (Ash, 2012). This is

especially important for reaching students in the alternative education community. Many alternative education schools are considered high needs schools due to the large percentage of students who are on record receiving free or reduced lunch. This information translates to a large number of students who live in homes without computers or Internet access. Many live in poverty and do not have consistent access to the internet. Tutoring programs usually occur in a school or at the library, so computers with Internet should always be available for those students. Students are often more likely to have Internet access on a cell phone than a home computer, so creating videos that are viewable by streaming video over a phone might allow even more students to access the learning information.

Some teachers and experts suggest limiting the volume material that is presented as "flipped" in order to diversify the delivery of information and better suit the diverse learning styles of all students (Ash, 2012). Those with experience in flipping the classroom seem to concur that breaking material into "bite-sized" chunks is beneficial to maintaining students' attention and allowing for a full understanding of the concept (Koller, 2011). Students may lose focus or not see the connections between multiple topics in longer more complicated videos (Kelly, 2012). Students will also be more likely to watch a shorter video in its entirety. Numerous videos on a variety of specific topics allow teachers to tailor each students' experience to the only content for which they need support (Koller, 2011). Feedback on each video may also provide valuable feedback as to which topics students are struggling with most. Opinions differ as to the maximum recommended time of the video. Recommendations range from three to fifteen minutes. All sources agree that engaging students through exercises, assessment,

and discussion is pertinent in addition to the viewing of the video. Based on the specific needs of at-risk and struggling students, videos for alternative education students will be a range from 2-8 minutes long and be accompanied by short worksheets to promote dialogue between the student and teacher regarding the topics at hand.

Kapus recommends including a text version of the narrative on videos for those whose abilities are better suited to reading than listening (2012). This aligns with the needs of many at-risk students because following written text along with the spoken narrative would also serve to improve literacy skills for students who struggle to read at grade level. This will be incorporated through the use of the LiveScribe pen and the nature of pencasts as videos. Additional details about creating pencasts can be found in the Methods section. In any video where there is more verbal explanation than written, a text version will also be provided.

Surveying students who have watched videos can help identify areas where information was unclear to them. Realizing these gaps and trouble spots will help with the creation of future videos. Supplemental resources, video or otherwise, could then be created to address frequently asked questions and misunderstood concepts and help students make sense of the material (Dervin, 1999).

Resources exist online that include applicable videos created by other educators. Some of these include Khan Academy, eduX, YouTube EDU, and PBS videos. The Khan Academy is an example of how online videos can be an extremely successful learning tool and is gaining attention for its success (Tucker, 2012). One program alternative education students are currently using is an online course curriculum called

Plato, which includes several videos and slideshows for each course per semester. These valuable resources are recommended to teachers who may be interested in testing a flipped approach in their classroom without committing to the creation of self-made videos. The important part of incorporating video into the classroom is the way in which the teacher guides the student to interact with the material (Tucker, 2012).

Methods:

Choosing appropriate content:

The central New York alternative education school featured in this study has adopted the Learning-Focused method of teaching. This teaching method is designed to include tools for organizing and revitalizing lessons and maximizing student engagement (Thompson & Thompson, 2008). Part of the unit organization process is to define an "Essential Question" for each lesson planned within the unit. These questions are intended to be very narrowly focused but thought provoking, and the coordinating lesson revolves around giving the students the ability to answer the Essential Question. Learner-Centered Design states the importance of understanding the needs of the learner, and many alternative education students struggle to understand and retain large amounts of information (Soloway et al, 1994). Essential Questions include a manageable amount of information for a short lesson, but students will usually have to use higher order thinking skills to answer them. For example, Essential Questions often ask students to explain, compare and contrast, or infer. This not only requires them to learn facts, but they must also have enough of an understanding to apply it to various scenarios. Learner-Centered Design states that "understanding is the goal for learners" (Soloway et al, 1994). Requiring students to apply new information rather than memorize shows that students have a good understanding of what they've learned.

Learning-Focused methodology is prevalent throughout the school in focus for this study and all teachers have received extensive training and evaluation to ensure that these methods are being used in the classroom. All of the teachers in the alternative education program have worked hard to organize their lessons by Essential Questions, so

building this into the video creation process may make this task more user-friendly and less intimidating. Therefore, the first step of video creation process is to choose concise information that aligns with one specific Essential Question.

Once the Essential Question is defined, the next step is writing the script for the video. All Living Environment videos contain material in accordance with the New York State Science Common Core Curriculum in Living Environment as they are intended to help students gain knowledge in this subject matter. The unit chosen for this set of videos is "Genetics of Inheritance." It was chosen due to its relatively straight forward content in comparison to longer, more vocabulary heavy units. Another reason for creating video for this unit is that it will be especially useful for teaching a particular problem solving skill, the Punnett Square, to students who are not present on the day of the initial lesson. A simplified "Unit Overview: Genetics of Inheritance," is found on the first page of the Appendix. Key vocabulary and skill objectives are included to establish growth goals as recommended for both Learning-Focused methodology and Learner-Centered Design.

The script for the video should contain the simple clear language due to the reading demographic of alternative education students. Taking the learners needs into consideration is of the utmost importance according to Learner-Centered Design (Soloway et al, 1994). The videos may introduce new scientific vocabulary, but that is because they are designed to teach science topics. Including unnecessary upper level non-science vocabulary could potentially frustrate students leading to disengagement. Use of higher level non-science vocabulary may be necessary to some degree in order to help students become familiar with common terms used on The Living Environment

Regents, but clarification should be included. For example in the script for Video 1, available for review on page 2 of the Appendix, the following statement is included: "Dominant allele is the gene that is expressed or shown." Students may not be familiar with the term "expressed," but it is commonly used when discussing genetics, so exposure with clarification is necessary. Full scripts for Videos 2 and 3 are found on pages 5 and 8 of the Appendix. Text versions of each video will be made available as a worksheet for any student. The essential science vocabulary for the unit should be closely considered as the script is being written, and in order to not overwhelm students, no more than four new science words should be introduced in each video. Each video should be between one and eight minutes in length as both the Flipped Classroom and Learner-Centered Design recommends keeping learners' attention span in mind while creating videos order to keep students attention for the entire duration.

Information in the videos should be presented in an organized fashion in order to avoid confusion. It is important not to jump around between topics. As evidenced in the script for Video 1 on page 2 of the Appendix, material flows in a logical manner and includes examples and summaries for additional support. In the script for Video 1, the first two terms defined are gene and chromosome, following those definitions and a simply drawing, an example is provided. The terms dominant and recessive are defined next and examples are provided. Next, a summary is provided and a sample question is answered to show students how information can be applied. This step by step approach is designed to be useable by learners at all skill levels because the abilities of alternative education vary.

Creating videos:

For this project, video pencasts were produced using the LiveScribe Echo Smartpen. This technology was chosen because of its ability to easily link spoken word with written notes and drawings, a format that students are familiar with already and will be helpful for a variety of topics. In order to create a pencast, the materials needed include the LiveScribe Echo Smartpen, its USB cord, and special "dot paper" that is necessary for the recording of the written notes. Downloading LiveScribe software to your computer is also necessary in order upload and work with these videos. The LiveScribe Pen and equipment are relatively inexpensive. It is also easy and quick to create and upload videos. As outlined in the research question, these qualities are both important due to the limited budgets and planning time of teachers.

To record, simply turn on the pen, touch the "record button" image which appears on the dot paper and begin speaking aloud and writing notes and diagrams. Upon the completion of the pencast, use the pen to touch the "stop button" image on the dot paper. The process should be very natural for teachers who use a traditional notes and lecture strategy. The easiest method for sharing these files is to upload them onto a computer using the USB cord, and then upload them onto the www.livescribe.com website. On the site, click the option to make the pencast public and choose the option to create a link. Without the option to view pencasts online, users must have LiveScribe software to view pencasts. There is currently no software available that works with the ".pencast" format to convert it to a more widely used format. By uploading the pencast, the link can now be embedded into a document or website so that others can access it by clicking on the link without having to download any LiveScribe software. The LiveScribe website is

easy to use, so this option made the most sense considering these pencasts will be accessed from multiple computers. Screenshots from Videos 1, 2, and 3 can be found on pages 3, 6, and 9 of the Appendix.

A corresponding worksheet was created to accompany each pencast. The link to each video as well as the lesson's Essential Question is at the top of each worksheet. The worksheets are intended to encourage engagement with the video content and provide an opportunity for feedback and interaction between the student and teacher. Worksheet questions are designed to lead students toward the ultimate task which is to answer to the lesson's Essential Question. The intentional scaffolding of information as seen in the worksheets is designed to lead students toward success thus increasing motivation and growth which are both considered primary goals of Learner-Centered Design (Soloway et al, 1994). As evidenced in the corresponding worksheets which can be found on pages 4, 7, and 10 of the Appendix, the first few questions are usually straightforward and require information that has been stated verbatim in the video. Questions found further along on the worksheets require students to apply that information, culminating in the answer to each video's Essential Question. In order to achieve consistency between video lessons and classroom lectures and activities, the lesson's Essential Question will always be present on the corresponding worksheet. Worksheets will be created using Microsoft Word and distributed to students by hand or made available on the computer as students prepare to begin the video assignment.

Anticipated Video Distribution Plan:

The intention of the project is to create a production process and self-evaluation process for adapting The Flipped Classroom to alternative education science classes, therefore videos were not shown to students for feedback as a part of this project.

It is anticipated, that eventually videos will be primarily used in the classroom as a tool to bring students who have missed content up to task with the rest of the class. Even though home Internet access has become more common, assigning a video as graded homework would be creating an unfair disadvantage and an extra obstacle for any student who does not have convenient access to broadband Internet. This is the primary reason that videos as graded homework will not be used, and the methods of the Flipped Classroom will be adapted for use inside the classroom instead. Using classroom computers with supervision will also ensure that students with motivational or behavioral problems are more likely to engage in the task. Two computers are available in a separate area of the classroom. Students who have missed lessons will view these videos on the desktop computers with headphones while the rest of the class works on current assignments with the assistance of the teacher. Students using the videos will be supervised by a teacher or a teaching assistant. This is to encourage students to remain on task while using the computer, but it will also be beneficial in case students have questions about the video content, operation of the video, or about the corresponding worksheet. At this point, links to the videos will be saved to the desktop of the computer and generally accessed from there alone. Students viewing materials from remote locations, such as an in school suspension room, will need a teacher to set up and supervise the viewing process. Links to the videos can be sent to other teachers by e-mail

as needed. When they are incorporated into the classroom, materials will augment, not replace, standard curriculum with the intent of helping students gain a better understanding of the topics covered in the classroom.

As depicted in the image above, the two classroom computers are seated several feet behind the rest of the classroom desk in close proximity to the teacher assistant's desk for supervision and guidance.

Video Self-Analysis Process:

A qualitative analysis procedure will be designed as the primary tool to measure the success of each video created for this project. As part of the creative process, each video will be assessed based on a set of questions to determine whether it meets the needs

of alternative education learners before being presented to students in a real educational setting. This process will be guided by Sharan B. Merriam's book called "Qualitative Research" as well as the book "Qualitative Interviewing" by Rubin and Rubin. Video assessment will utilize principles of Learner-Centered Design and take into consideration the unique needs of alternative education population.

The "Video Self-Evaluation Tool" is a single page document that can be completed after watching the videos, or in this case, pencasts. The video self-evaluation process will help determine whether or not the videos accomplish their goals. Each time a video is created, a series of video self-evaluation questions will be answered by the teacher who created the video. The form will essentially serve as an "interview" or checklist for each video that has been created. Although it is intended mainly for self-evaluation, it can be completed by colleagues or peers for additional feedback which can be helpful for additional guidance during the creative process. This document includes questions regarding the unique needs of alternative education students regarding content, complexity, and length and is available for review in the Appendix. For each of the three videos in this project, a copy of the evaluation sheet was filled out by myself and three colleagues all of whom teach different courses in alternative education and use technology in their classrooms to various degrees. When reviewing the videos, each colleague also received the worksheet and script of the video as well as a copy of the unit overview that was used during the creation process in order to help them be more familiar with the content.

As self-evaluation feedback accumulates, the creative and evaluative process may be susceptible to change. This continuous procedure provides valuable information to

help in the improvement of video resources and ensures that these resources will constantly remain relevant and valuable.

Results:

Following the process outlined in the methods section made the creation of videos simple. Utilizing the Learner-Focused format to organize the content the videos was convenient because lesson Essential Questions are already linked to content meaning that the content of the videos is largely preplanned. Each Essential Question resulted in about a five minute video, which is well within the recommendations for video length as discussed in the Literature Review. Prewriting the script for the videos allows for a smoother video creation process as well as a clearer more organized video with less pause and repetition.

Self-evaluation as well as colleague feedback was largely positive for the pencasts that were created. The feedback was collected and compiled in a single document that can be found in the Appendix. Many of the responses to the first section of the self-evaluation were similar and are paraphrased in the attached document to avoid repetition. The answers to the second portion of the document regarding anticipated student use were more diverse, so direct quotes were included.

Feedback regarding the length of the videos and the language used supported the idea that simple language and less than four new content-specific vocabulary words at a time are most appropriate for alternative education students. Another colleague stated, "Providing both spoken form and text of the video will help learners with different strengths – and might even help improve literacy of struggling readers," which was the exact intention of this feature of the project. Many of the guidelines of Learner-Centered Design are inherent to teachers as they adapt resources to their students' needs often, so appealing to multiple modalities among students is something commonly discussed

among teachers. Most teachers are constantly looking for ways present content in multiple ways, however, it is fairly difficult to achieve within one assignment, so for this reason, a video with a printed script could appeal to teachers in any subject matter. A math teacher who typically sticks to traditional teaching methods suggested that creating pencasts would be easier and more relevant to mathematics than other popular methods of technology. Technology based presentations like PowerPoint tend to be less useful in mathematics classrooms because it is very difficult to use typed text to work through a math problem. A pencast could be just as helpful as explaining to a student how to do a problem in person, but it has the potential to be used asynchronously.

Feedback from one colleague that stated, "I don't have neat enough handwriting to use a tool like this," was likely added in jest, but it points out what may be the biggest potential flaw of this particular technology. After multiple attempts to create professional looking videos, I came to the realization that by nature, these pencasts would never look as "professional" or nearly as neat as a typed document or presentation. The handwritten and conversational feel of pencasts could be considered a benefit in some ways. Physically writing the notes throughout the pencast slows things down and gives students time to take in the information and write notes if they choose to. The slower conversational tone may be less intimidating and easier to understand than a typical science video or higher level text. However, the visual appeal and neatness depends completely on the handwriting and artistry of the user which is highly variable. I don't think this should deter teachers from pursuing this technology, but because of this, other types of visuals and video technology would still be needed to explain certain topics.

The most important feedback from colleagues was that overall they felt that the pencasts and corresponding worksheets were appropriate for and could potentially benefit alternative education students. This is very positive as it supports the goal of using Learner-Centered Design and creating resources appropriate for alternative education students. The self-evaluation form will continue to be a useful guidance tool as additional videos are made. Using it as a checklist during the creation process is also a useful way to make sure that videos continue to take the specific needs of alternative education students into consideration. The influence of Learner-Centered Design was most valuable as a reminder that the students' specific learning and motivational needs are a priority when creating new teaching tools. .

The feedback was valuable in answering the research questions defined earlier in the study. The first question asked: **How can Learner-Centered Design and the Flipped Classroom help influence the creation of effective learning tools for alternative education students?** Learner-Centered Design emphasizes that learners are different from "users" as defined in User-Centered Design and have specific needs that need to be considered. For learners on of the first guidelines states that understanding is the goal (Soloway et al, 1994). The videos are intended to impart an understanding on subject matter rather than simply exist as a tool to be used. In order to adhere to this guideline, worksheets were designed to correspond with each video and check the students' understanding throughout the learning process. Another guideline of Learner-Centered Design states that diversity is the norm (Soloway et al, 1994). This refers to cultural diversity as well as diversity in ability and previous knowledge base. As referenced previously the average alternative education student reads and writes below

the expectation for his or her grade level. In order to improve comprehension, material was divided into small lessons and presented in very short videos. Language in videos was simplified, and new content related terms were limited to four per video. Keeping material at a level that students are comfortable with helps prevent them from losing motivation, which leads into another of Soloway's guidelines for Learner-Centered Design: motivation is the basis (1994). Intimidating tasks can often lead to resistance and disengagement in alternative education students. Short, simplified videos were intended to appeal to students who struggle with grasping material from text alone. This also begins to answer the second research question previously posed: **How can the Flipped Classroom methodology be adapted to alternative education science students?** Videos are intended to be watched at home according to the original design of the Flipped Classroom. Interestingly, the final format of adapting the Flipped Classroom to the needs of alternative education students looks very different from the way the Flipped Classroom was originally designed. In alternative education, students often lack the motivation to engage in classwork let alone homework, so the video assignments are intended to be implemented in the classroom under the supervision of a teacher or teacher's assistant. Supervision will allow for assistance and clarification when necessary as well as provide a watchful eye for students who are easily distracted by other features available on the computer. The most important practice that it inspires is the concept of giving a student the opportunity to learn independently by providing a video lesson while being available to help with practice and application afterward. I anticipate that this will become increasingly valuable as this practice is integrated into my classroom.

Continuation:

This project will soon be integrated into my daily classroom activities and I truly believe that it will be beneficial to my students. I will continue to develop and improve my video resources and change how they are used with my students. I plan to explore other video creation technology in addition to using the LiveScribe pen to create pencasts. I anticipate that eventually student success and feedback will begin to influence the production process of the videos and the way they are distributed.

As the January Regents session draws near, these videos, as well as similar review-specific videos, will become a useful resource among students. Students who are retaking the Living Environment Regents often lack time in their schedules to come in and review, but the asynchronous nature of these videos is an exciting option with a lot of potential.

I plan to periodically turn to colleagues for qualitative feedback to ensure that the quality and appropriateness of the videos remains high. At this point other teachers are interested, but no one has worked with me to create their own video material. If interest continues, there is a possibility that a workshop could be offered for other teachers as a professional development opportunity during the spring semester of the 2013-14 school year.

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Appendix 1

Unit Overview: Genetics of Inheritance

<table>
<tr><td colspan="3">Unit Essential Question: How do organisms pass information from parent to offspring?</td></tr>
<tr><td colspan="3">Unit Key Vocabulary: gene, allele, double stranded chromosome, dominant, recessive, genotype, phenotype, homozygous, heterozygous, Punnett Square</td></tr>
<tr><td colspan="3">Lesson Essential Questions:</td></tr>
<tr><td>Lesson 1: How do genes and alleles affect your traits?</td><td>Lesson 2: How does the genotype of an organism determine its phenotype?</td><td>Lesson 3: How do Punnett Squares help scientists?</td></tr>
<tr><td>Lesson 1 Vocabulary:
gene, allele, double stranded chromosome, dominant, recessive</td><td>Lesson 2 Vocabulary:
genotype, phenotype, homozygous, heterozygous</td><td>Lesson 3 Vocabulary:
Punnett Square</td></tr>
<tr><td>Lesson 1 Skills:
♣ Identify picture of double stranded chromosome, with the understanding that there are two copies of each gene present.
♣ Identify dominant vs. recessive alleles by capital and lower case letters
♣ Understand that the dominant allele covers up a recessive allele when both are present</td><td>Lesson 2 Skills:
♣ Explain that a genotype includes information that codes for physical traits or phenotype.
♣ Identify whether a genotype is homozygous or heterozygous.</td><td>Lesson 3 Skills:
♣ Set up and complete a Punnett Square when given genotypes of two parents.
♣ Determine probability of certain outcome by viewing a completed Punnett Square.</td></tr>
</table>

Appendix 2

Text version of video script: Unit: Genetics of Inheritance, Video 1

Essential Question/Title: How do genes and alleles affect your traits?

A gene is a section of DNA that codes for a certain trait in organisms. Organisms have genes that control all of their physical traits such as color, height, and shape. Genes can sometimes control skills and abilities as well, for example, humans even have genes that control whether or not you they are able to roll their tongues!

Your genes are on your chromosomes, which look like this. (Draw double stranded chromosome.) This is a double stranded chromosome. It is double stranded because you get one strand from your mother and one strand from your father. This means you have two copies of the gene for every trait.

Alleles are the different ways each trait can show up, for example the ability to roll your tongue, or the inability to roll your tongue. For each gene, you have two alleles – one from your mother, and one from your father. This is why offspring usually look like a combination of both of their parents.

How do you know which parent's allele will show up?

You can never know for sure how the offspring of two parents will turn out, but here are two words that might help you figure it out:

Dominant allele is the gene that is expressed or shown. If it is present, it masks or covers up the other allele. The dominant allele is represented by a capital letter. Being able to roll your tongue is dominant, so we could represent it with a capital "R."

The recessive allele is the gene that is present but is not expressed. If a dominant allele is also present, it will mask or cover up the recessive allele. The recessive allele is represented by a lower case letter. Not being able to roll your tongue is a recessive trait, so we could represent it with a lower case "r."

So to summarize, if we are talking about the gene for tongue rolling, you know you get one allele from your mother, and one allele from your father. If you got a dominant allele from your father and a recessive allele from your mother, we would write it like this: Rr.

If those were your genes for tongue rolling, would you be able to roll your tongue? (pause) If you answered yes, you were correct!

Now try the questions on your worksheet. If you need to re-watch the video, just press play again.

Appendix 3

Screenshot of Video 1:

How do genes and alleles affect your traits?

gene = DNA codes for a trait

chromosomes

Alleles = ways trait can show up

Dominant = gene that is expressed
covers up
R = can roll tongue

Recessive = not expressed
r = can't roll tongue

Rr

Yes!

Appendix 4

Name: _____

Living Environment Sullivan

Video Essential Question: How do genes and alleles affect your traits?

DIRECTIONS:

- ♣ Watch the video at the following link: http://www.livescribe.com/cgi-bin/WebObjects/LDApp.woa/wa/MLSOverviewPage?sid=XLS5g4cFZrZL
- ♣ Complete the following questions

1) What are genes made up of?

2) Name three examples of traits controlled by genes.

3) Where do each side of our double stranded chromosomes come from?

4) How many copies of each gene do we have?

5) What is the name for the type of allele that "covers up" other alleles?

6) What is the name for the type of allele that gets "covered up"?

7) If "T" is an allele for tall plants, and "t" is an allele for short plants, which is a dominant allele, tall or short?

8) Would a plant with the genes "Tt" be tall or short?

9) Would a plant with the genes "tt" be tall or short?

Appendix 5

Text version of video script: Unit: Genetics of Inheritance, Video 2

Essential Question/Title: How does the genotype of an organism determine its phenotype?

A phenotype of an organism is its physical appearance or what it looks like. Phenotype and physical appearance both start which PH which can help you remember. For example, a pea plant's phenotype for height could be tall or short.

A genotype of an organism is made up of the genes it receives from its parents. Genotype is made up of a combination of letters that represent dominant and recessive alleles.

For example, in pea plants capital T is the allele for tall plants. Lower case t is the allele for short plants. A pea plant that receives a capital T from one parent and a lower case t from the other parent would have the genotype Tt.

Looking at an organism's genotype allows you to figure out its phenotype, or what it looks like. If you look at the genotype we just wrote, and remember the meaning of dominant and recessive, you can figure out whether that pea plant is tall or short.

(Here's a reminder: a dominant allele "takes over" and is represented by a capital letter, and a recessive allele is "masked" and is represented by a lower case letter.)

Think for a moment - What would be the phenotype of an organism with the genotype Tt?

(pause)

The capital T would mask the lower case t, and the phenotype of the pea plant would be tall.

There are names for different combinations within genotypes.

Homozygous genotypes have two of the same alleles, such as TT or tt.

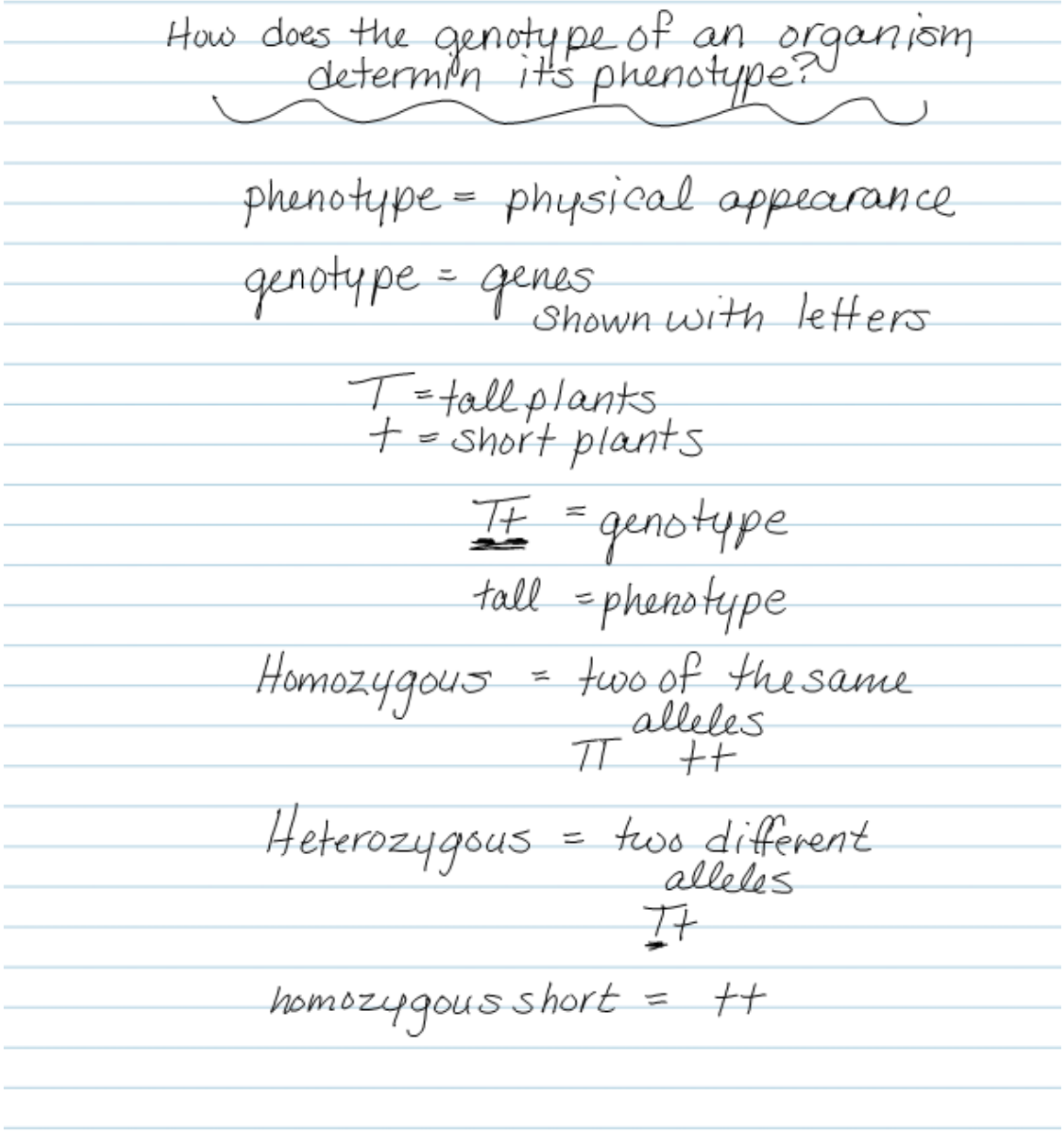
Heterozygous genotypes have two different alleles, such as Tt. Whenever we write heterozygous genotypes, it is common practice to write the capital letter first.

Think for a moment - How would you write a genotype for a pea plant that was homozygous for shortness?

The genotype for homozygous short would be tt.

Appendix 6

Screenshot of Video 2:



Appendix 7

Name: _____

Living Environment Sullivan

Video Essential Question:

How does the genotype of an organism determine its phenotype?

DIRECTIONS:

- Watch the video at the following link: http://www.livescribe.com/cgi-bin/WebObjects/LDApp.woa/wa/MLSOverviewPage?sid=rcr5phsJtLrL
- Complete the following questions

1) What is the difference between a genotype and a phenotype?

2) Is "RR," (two dominant alleles for tongue rolling,) a genotype or a phenotype?

3) When you look at an organism, which is easier to determine for certain, the genotype or the phenotype?

4) If "T" is the allele for tall plants, and "t" is the allele for short plants, what is the only possible genotype for a short plant?

5) Describe one similarity and one difference between homozygous genotypes and heterozygous genotypes.

6) Write the genotype for homozygous tall.

Appendix 8

Text version of video script: Unit: Genetics of Inheritance, Video 3

Essential Question/Title: How do Punnett Squares help scientists?

Punnett squares are a method that can help determine the possible offspring of two individuals. If you know the genotype of both parents, you can figure out the genotypes that would be possible for their offspring, and you can figure out the probability of them having a certain type of offspring.

To do a Punnett Square, you start by writing out the genotypes of the parents you are going to cross like this:

TT x Tt (Here we have one parent with two dominant alleles for tallness which is also called homozygous tall, and one parent with one tall and one short allele, which is also called heterozygous tall.)

Next we draw the Punnett Square box: (draw)

Now we write the genotype of one parent above the top of the box, and the genotype of the other parent down the outer left side of the box. (write)

Next we will fill in the inner boxes of the Punnett Square with the genotypes of the potential offspring of these two parents by looking above and to the left of each box.

Look above this box and you see a capital T, write that inside the box. Look to the left and you see another capital T, write that also. We have now completed the first box with the genotype of one possible offspring of TT x Tt.

By looking above and to the left of the second box, once again we see a capital T in both places. Again we will write TT in this box.

In the third box, we still look way up above to see a capital T. To the left this time we see a lower case t, so we will write Tt.

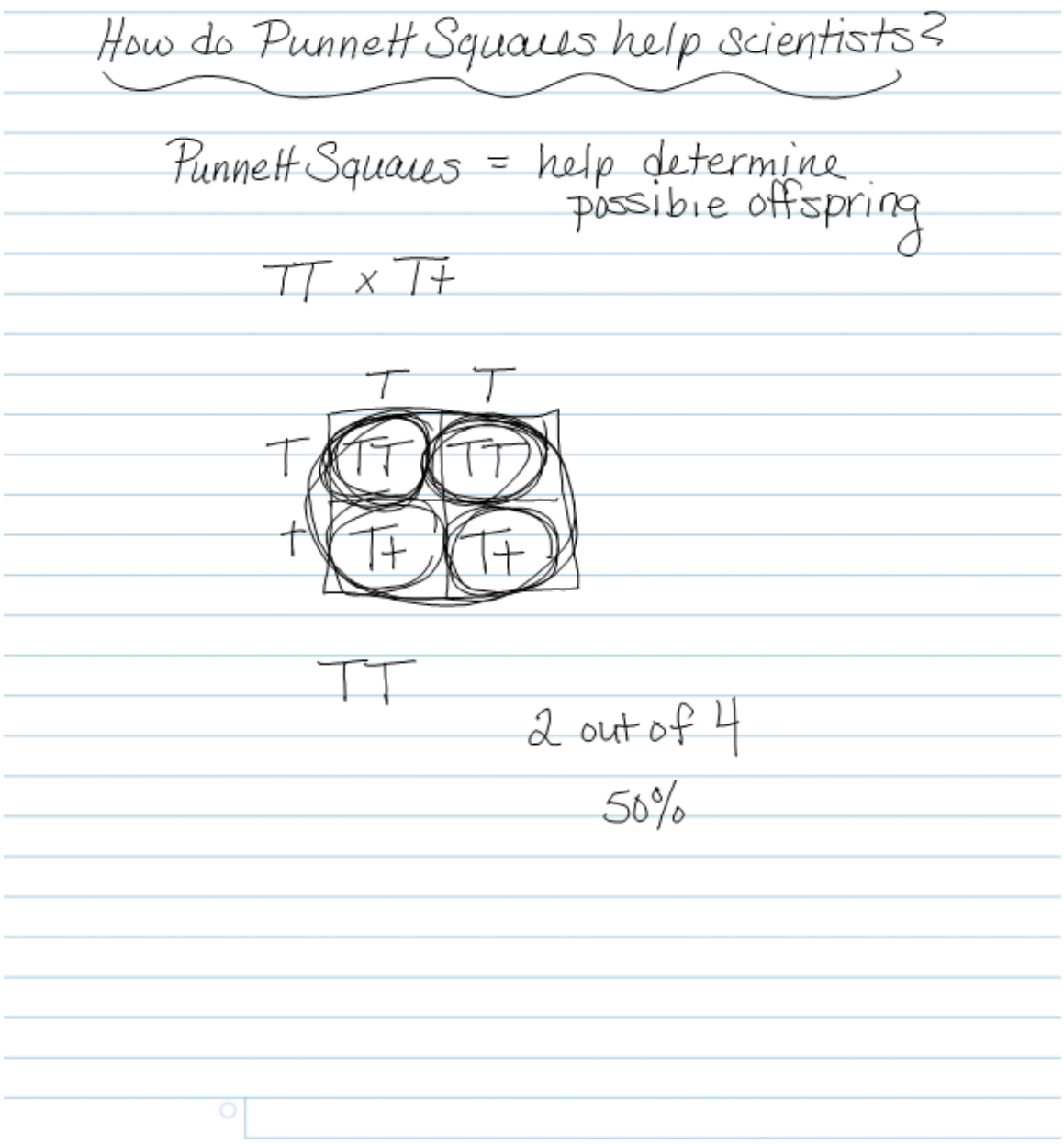
In the last box, we look way above to see a capital T, and way to the left to see a lower case t, so once again we write Tt.

These four boxes now contain the four possible offspring for the parents TT x Tt.

We can look at these boxes to determine the probability of these parents having a certain type of offspring. For example, if I asked: “What is the chance of having a homozygous tall offspring?” You could look at the boxes, see that 2 out of 4 of them are TT, and then tell me that the probability is 2 out of 4 or 50%.

Appendix 9

Screenshot of Video 3:



Appendix 10

Name: _____

Living Environment Sullivan

Video Essential Question: How do Punnett Squares help scientists?

DIRECTIONS:

- ♣ Watch the video at the following link: http://www.livescribe.com/cgi-bin/WebObjects/LDApp.woa/wa/MLSOverviewPage?sid=XDR8d2h2k8hX
- ♣ Complete the following questions

1) What can you determine by using a Punnett Square?

2) Write out the cross between a mother who is heterozygous for tongue rolling and a father who is heterozygous for tongue rolling. (Use R and r for tongue rolling.)

___ ___ X ___ ___

3) Draw and complete the Punnett Square for the two individuals listed above:

4) What is the probability that the above two individuals will have offspring that is "RR"?

5) What is the probability that they will have heterozygous offspring?

Appendix 11

Video Self-Evaluation Tool

Video Essential Question: _____

Self-Evaluation:

	Yes/No	Comment:
Is the content of the video aligned with the objective or "Essential Question" of a single lesson?		
Are there visuals included in the video?		
Is a complete text version of the video available?		
Is the video between 1 and 8 minutes?		
What prior learning is linked back to in the video?*		
Does the video introduce information to which future learning connections will be made?*		
Is the content organized in a logical, easy to follow manner?		
How many new content specific terms are introduced? (Goal: 4 or less)		
Is the language in the video simplified and easy for students to understand (with the exception of necessary content specific terms)?		
By the end of the video, is enough information given to answer the "Essential Question?"		
Is there some form of written or verbal assessment to summarize and check understanding?		

*Both of these standards may not be met in an introductory or final lesson of a unit.

Anticipation of student use:

Consider the video through a student's perspective:

- ♣ What questions might student asks regarding lesson content? Are there any parts that might be unclear or confusing without advanced knowledge?

- ♣ How many questions are direct informational questions? (You want to set students up for success, but still require some thought. A ratio of ~50% direct information and ~50% application questions is ideal.)

- ♣ Additional Comments:

Appendix 12

Compilation of Feedback from Video Self-Evaluation and Colleague Evaluation

	Yes/No	Comment:
Is the content of the video aligned with the objective or "Essential Question" of a single lesson?	Yes	♣ *All videos coordinate with a specific "Lesson Essential Question" from an the unit "Genetics of Inheritance."* ♣ *Lessons cover key vocabulary and skills for each lesson.*
Are there visuals included in the video?	-	♣ *Video 1 & 3 include simple drawings and figures.* ♣ *Video 2 has nothing but text.* ♣ *Overall videos are very simple visually.* ♣ *No color, no photos*
Is a complete text version of the video available?	Yes	♣ *Script of each video is present.* ♣ *Portions of script that are written out in the pencast are underlined in the script.* ♣ *There are some very minor discrepancies between the script and the video*
Is the video between 1 and 8 minutes?	Yes	*Videos are 4:56, 5:19, and 4:26*
What prior learning is linked back to in the video?*		♣ *Video 1 was an introductory video, but still drew on prior knowledge for the understanding of the words DNA, organisms, physical traits, and offspring.* ♣ *Video 2 used the terms gene, allele, dominant, and recessive from Video 1.* ♣ *Video three used terms from both previous videos.*
Does the video introduce information to which future learning connections will be made?*	Yes	♣ *Each video contains information from the previous video.* ♣ *Even video three introduces new information that will be built upon as we move forward onto genetic applications.*
Is the content organized in a logical, easy to follow manner?		♣ *Content moves at a slow pace and progresses from one topic to the next.* ♣ *Summary of information at the end may seem like "jumping around" to a student who has not gained a good understanding of*

		the subject matter.
How many new content specific terms are introduced? (Goal: 4 or less)		♣ *Video 1: 5* ♣ *Video 2: 4* ♣ *Video 3: 1*
Is the language in the video simplified and easy for students to understand (with the exception of necessary content specific terms)?		♣ *Videos do assume the understanding of a couple somewhat complex words.* ♣ *Words that may need to be reviewed with some students include: probability, potential, and cross*
By the end of the video, is enough information given to answer the "Essential Question?"	Yes	♣ *Answers are not stated in obvious question/answer format, but all necessary information is present.*
Is there some form of written or verbal assessment to summarize and check understanding?	Yes	♣ *Corresponding worksheets are available for all three videos.*

*Both of these standards may not be met in an introductory or final lesson of a unit.

Anticipation of student use:

Consider the video through a student's perspective:

♣ What questions might student asks regarding lesson content? Are there any parts that might be unclear or confusing without advanced knowledge?

- *Students may need more practice to master the skills for each lesson.*
- *For some students, Punnett Squares may require more samples to be completed together before being able to complete them independently.*

♣ How clearly stated are the answers to the corresponding questions? (You want to set students up for success, but still require some thought. A ratio of ~50% direct information and ~50% application questions is ideal.)

- *The worksheet for Video 1 includes six questions with answers directly from the video and three questions that require application of information.*
- *The worksheet for Video 2 includes two questions with answers directly from the video and four questions that require application of information.*
- *The worksheet for Video 3 includes one question with answers directly from the video and four questions that require application of information.*
- *None of the videos have a perfect 50/50 ratio between direct and application questions, but throughout all three videos the ratio is 9 to 11 which is fairly close.*

♣ Additional Comments (from colleagues):

- “Videos are short enough that they shouldn’t lose students’ attention. Keeping the worksheets short is good to make the whole task less intimidating so that it’s more likely a student will attempt it.”
- “Providing both spoken form and text of the video will help learners with different strengths – and might even help improve literacy of struggling readers.”
- “I would be interested in making short videos like this. It might be a tool students could use for a project as well.”
- “I don’t have neat enough handwriting to use a tool like this.”
- “This would be much easier than typing out math problems on a PowerPoint presentation.”