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# Using Technology's Internet Resources in Algebra 1

## Introduction

Technology is a means that makes work or tasks easy, efficient, and operative. A more encompassing definition refers to it "as the tools created by human knowledge of how to combine resources to produce desired products, to solve problems, fulfill needs, or satisfy wants." (Koehler and Mishra. 2008:5) It can either be contrivances of tradition or modernization. In education, these can be "specific, stable, and transparent" as analogs like pens and papers or "protean, unstable, and opaque" as digitals akin to computers and softwares. (Lee. 2008: 129; Koehler and Mishra. 2008:5) In mathematics, "technology influences the mathematics that is taught and enhances students' learning." (Kastberg and Leatham. 2005:33) With Algebra 1, where students' thinking develops from concrete to abstract, technology plays an essential role that facilitates this cognitive transformation. A vital part, which helps students understand the "theories for the solution of equations, finding values of the unknown quantities, or the conditions under which they can or cannot be found" in Algebra. (Bunch. 2009:online)

## Methodical Strategy

The technology emphasized in this text is the prevailing utility of the Internet web. There are instructional values in the information superhighway. Knowing the varied types of softwares or applications made available on the Internet web; whether in real-time, as downloads, or obtainable in digitally stored discs, paves the way to understanding its usefulness as well as acquiring strategic skills of employing it. According to Kurz, Middleton, and Yanik, there are five types of softwares: *review and practice, general, specific, environment,* and *communication* (2005).

Beginning with *review and practice*, these are primarily for checking and drilling on concepts already learned. They involved ideas that can be readily presented through direct instruction, can be deduced from the textbook, or can be carried out with pen-and-paper worksheets. Critics indicated that with its use, "there is no harm done, but no good is done, either" but for immediate feedback. For it to be effective, there must be "scaffolding questions built in." (2005: 124-126) Exemplifying one of the commendable virtual manipulatives online; the site for National Library of Virtual Manipulatives (www.nlvm.usu.edu) exhibits both banal and efficient activities. The tasks under Balance Scales define the triteness attribute of *review and practice* where students used labeled cubes to balance a scale that signifies a given equation (Figure 1). However, the logical thinking and abstract reasoning entailed in solving the Coin Problem is a meaningful work of discovery, in which the students explore solutions of finding a counterfeit coin by balancing the scale within certain parameters (Figure 2).

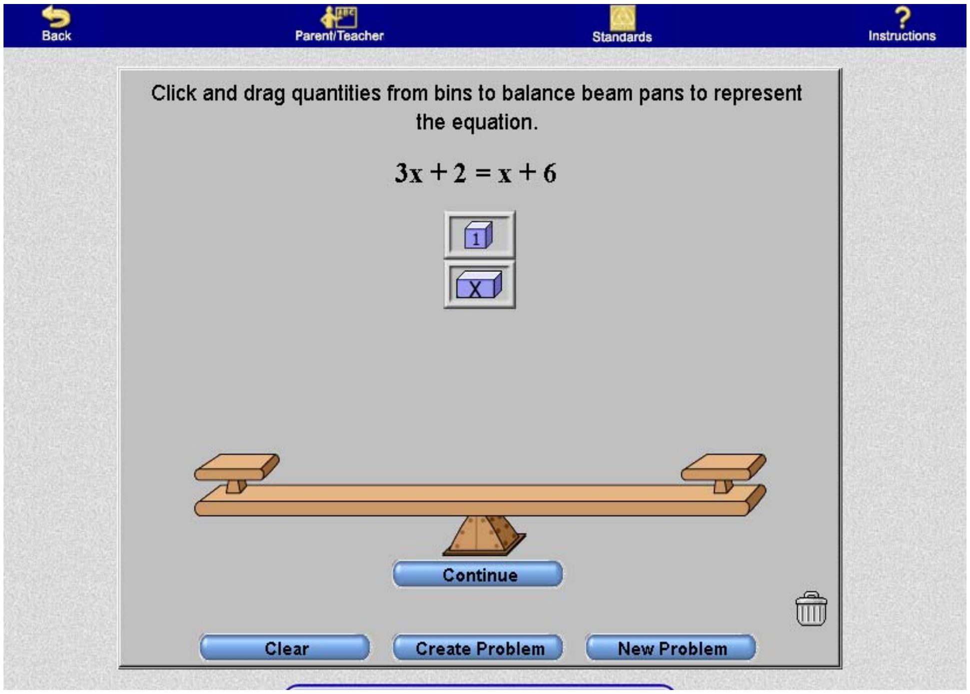



**Figure 1:** *Balance Scales.* Labeled cubes are used to balance the scale and thus, solve the given equation. A task of review and practice since there's no new concept being learned.

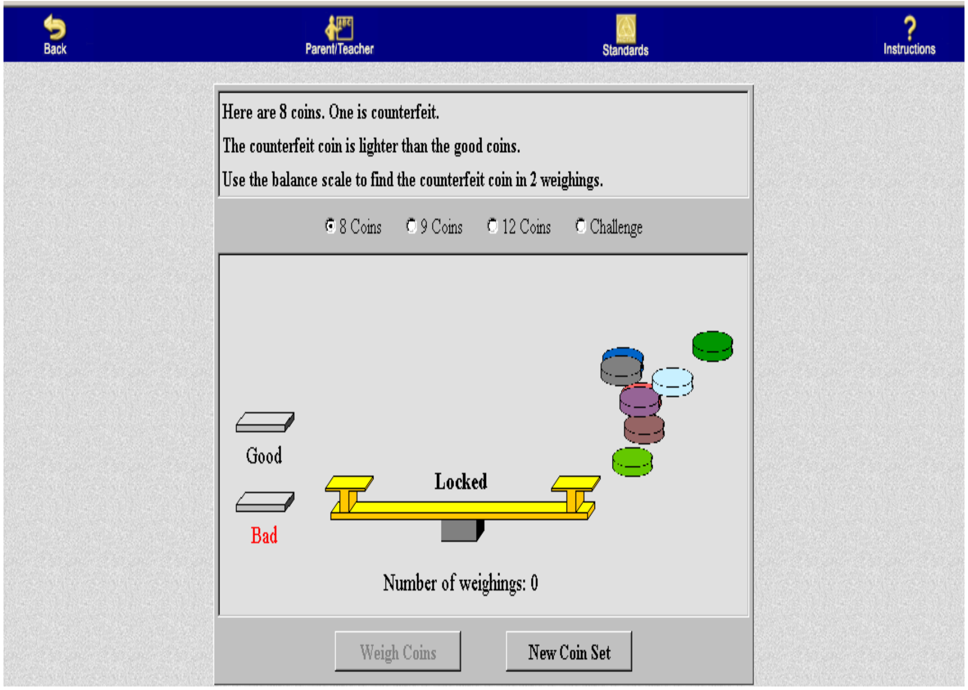



**Figure 2:** *Coin Problem.* This example provides students opportunities to explore solutions. It enhances logical thinking and abstract reasoning in progressing levels of difficulty.

In the *general* category, the program covers several areas of mathematics with varying applications. A valuable example is Geogebra. It is a "dynamic mathematics software for all levels of education that joins arithmetic, geometry, algebra and calculus." (geogebra.org: 2009) In Algebra 1, it permits users to explore possibilities in presenting equations and its coordinates as well as examine a range of functions individually plotted. (Figure 3) Additionally, Geogebra is customizable for specific topics and word problems such as solving equalities and inequalities numerically, algebraically, and graphically. As a freeware, it is not unexpected for numerous websites to offer Geogebra applets for various mathematics activities. Research shows that *general* applications as Geogebra helps students understand the mathematics quickly by providing them opportunities to delve deeper into the mathematics problems and to discover the concepts behind them through visual manipulations that make it viable for them to make justifiable conclusions. (Kurz et. al. 2005:126-127)

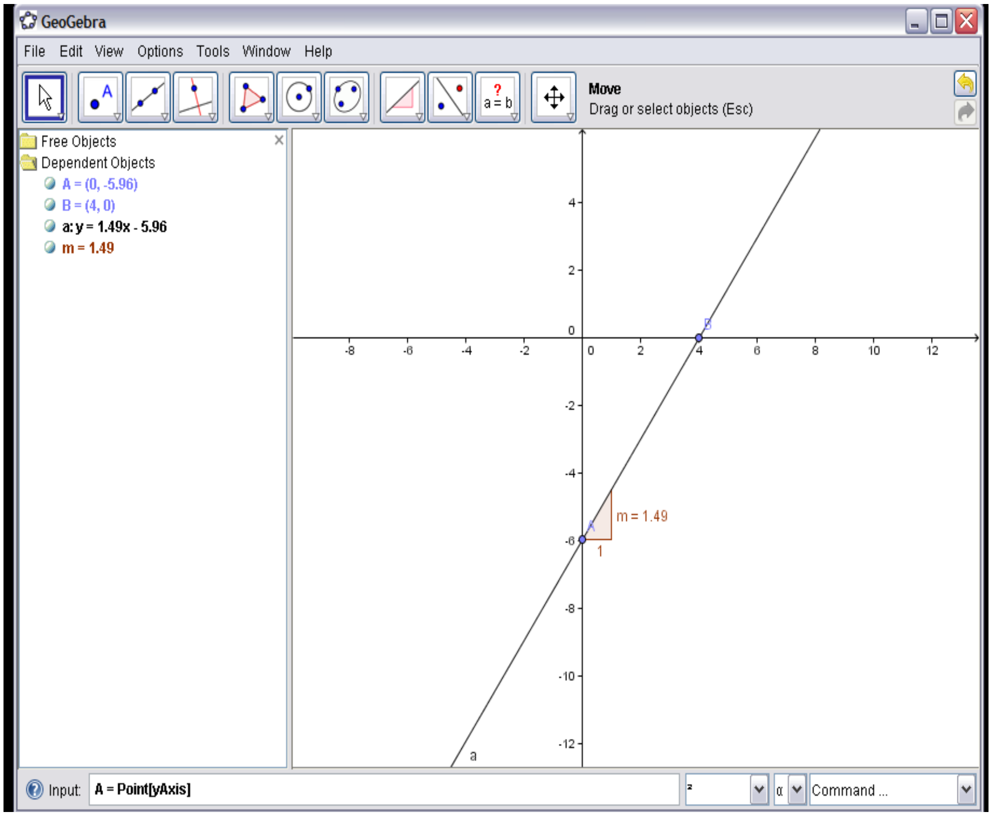
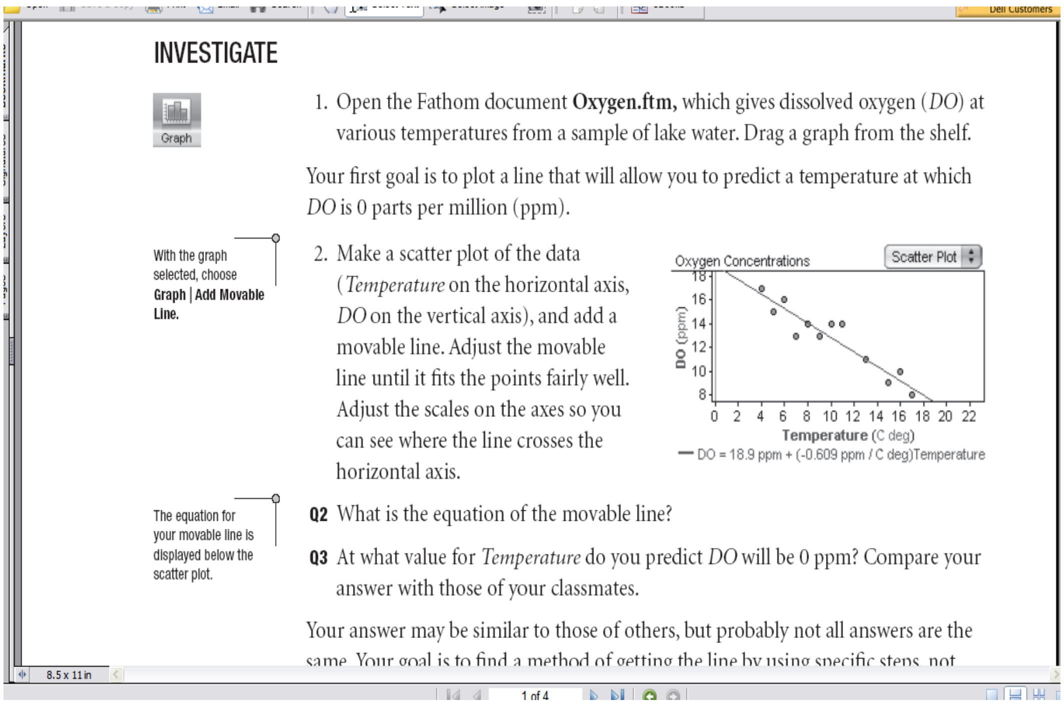



**Figure 3:** *Geogebra*. It permits users to explore possibilities in presenting equations and its coordinates. Here, the users can move points A and B. By discovery, they should be able to find out the patterns for a slope at 0 and the undefined slope, on top of finding out the negative and the positive slopes. A challenge task is looking for lines (equations) with the same slope.

Coming down to *specific*, a fresh concept is introduced. The application concentrates on a particular area. Thus, guidelines are more definite and more directed towards a specialized learning. A model of specificity is Fathom, which emphasizes on data analysis. How does this relate to Algebra 1? Probing into the statistical samples gathered require Algebraic evaluation of the relationships between its variables. For instance, investigating on the linearity of oxygen concentration and water temperature necessitates students to assess the connection between the two, whether direct or indirect; positive or negative. Therefore, it entails the creation of a function to validate the data. (Figure 4) In this case, Algebra is employed to learn data analysis. The essential advantage of *specific* softwares, which are abundant on the web, is acquiring a particular skill at a reasonably brief time with an identifiable feedback that gives the students appropriate guidance to learn the new material.



INVESTIGATE

Graph

1. Open the Fathom document **Oxygen.ftm,** which gives dissolved oxygen (*DO*) at various temperatures from a sample of lake water. Drag a graph from the shelf.

Your first goal is to plot a line that will allow you to predict a temperature at which *DO* is 0 parts per million (ppm).

With the graph selected, choose **Graph | Add Movable Line.**

2. Make a scatter plot of the data (*Temperature* on the horizontal axis, *DO* on the vertical axis), and add a movable line. Adjust the movable line until it fits the points fairly well. Adjust the scales on the axes so you can see where the line crosses the horizontal axis.



The equation for your movable line is displayed below the scatter plot.

**Q2** What is the equation of the movable line?

**Q3** At what value for *Temperature* do you predict *DO* will be 0 ppm? Compare your answer with those of your classmates.

Your answer may be similar to those of others, but probably not all answers are the same. Your goal is to find a method of getting the line by using specific steps, not

**Figure 4**: *Fathom*. Looking into the link between oxygen concentration and water temperature is an activity of Linear Modeling where Algebra is used to learn data analysis. (http://www.keycollege.com/ws/Fathom/datafiles.html)

As for *environment*, it “provides a contextual setting not normally possible in the classroom, allowing students to make investigations into complex, often real-world applications of mathematics.” (Kurz et. al. 2005:128) It presents actual experiences and issues in simulated mode for students to probe into with their mathematical knowledge, to explore for mathematical ways to solve them, and to zoom in to the most feasible mathematical solution for these problems without physically leaving the classroom. The Jasper Project is a reputable model. Its sample Algebra 1 video vignette entitled "Working Smart" shows a 20-minute web movie about the dilemma of maximizing earnings for three friends using SMART tools that included diagrams and graphs. This is followed by a challenge to have the students apply mathematics in formulating the various resolutions given the guided information that is designed for scaffolding. (Figure 5) Studies revealed that the nature of this learning activity "increase[s] their [the students] self-concept and interest in mathematics in addition to greater competence." (Kurz et. al. 2005:129)

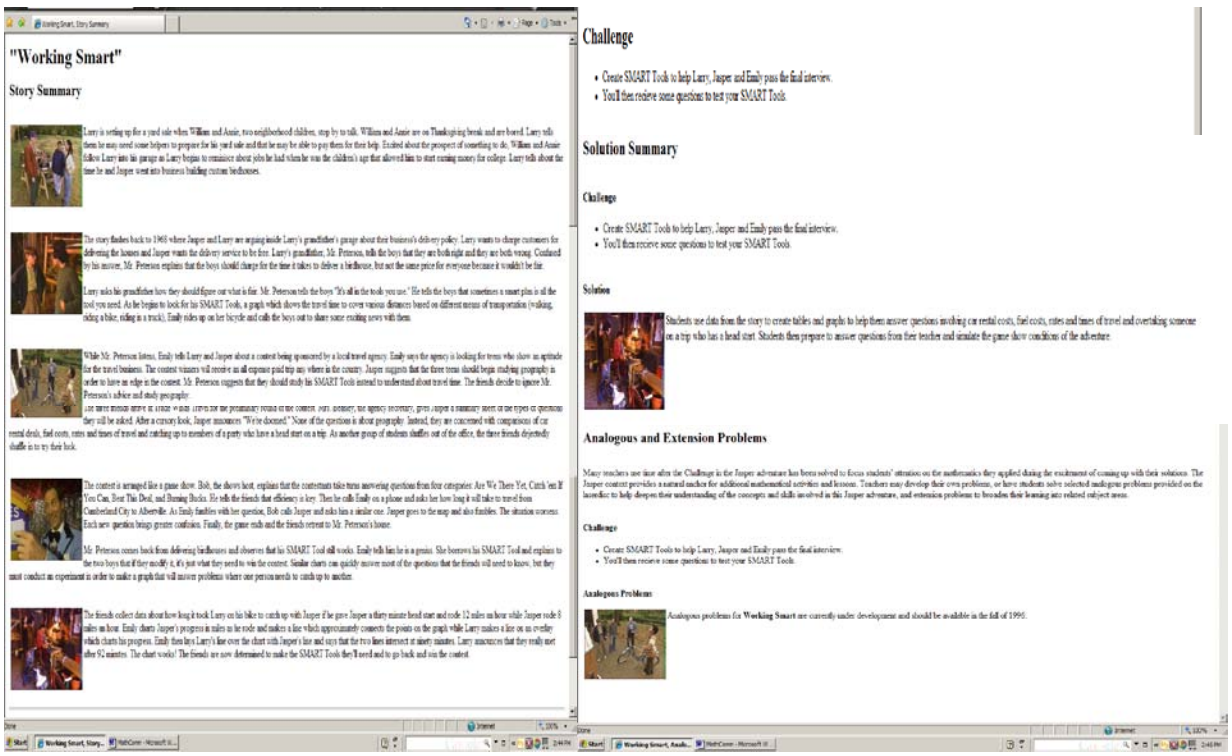



**Figure 5:** *The Jasper Project*. An Algebra sampler with story summary, challenge tasks, solution summary, and extended problems.
http://peabody.vanderbilt.edu/projects/funded/jasper/preview/AdvJW.html

In terms of *communication*, the main purpose is to establish a channel for open discussions about mathematics concepts beyond classroom instruction. It involves online correspondences between teachers and students within a group or members of a community and others who are outside of this community. "Groupware, videoconferencing, chats, electronic bulletin boards, e -mail, and listserv" are a few of these. For Algebra, it is worthy to bring up Math Forum's Problem of the Week (POW). It offers opportunities for students, with the teacher's facilitation, to tackle thought-provoking mathematical problems. First, they try a problem individually. Followed by conferencing with the teacher, then, posting their efforts online for additional assistance or for further guidance from Math Forum (www.mathforum.org). Hence, a site for exchanging views. When students arrived at a solution, these students, the teachers, and other groups embarking on the same problem log on to a discussion forum where there is a communal meeting of minds regarding the solution and its entailing concepts. There are numerous Internet sources that offer *communication*: giving more time for students to ponder on a mathematical concern in depth as opposed to the immediacy of response in the classroom, getting a chance to communicate about and query on ideas to others beyond class, having more frequent interface with the teacher even though it's virtual, and promoting "higher order cognitive thinking." (Kurz et. al. 2005:131)

These wealth of essentials lead to strategic ways of learning Algebra 1. Pursuing Garofalo, Drier, Harper, Timmerman, and Shockey's interconnected rules to applying technology, and in this regard, its Internet resources, these are: "introduce technology in context, address worthwhile mathematics with appropriate pedagogy, take advantage of technology, connect mathematics topics, and incorporate multiple representations." (2000:67)

When a mathematics curriculum is accentuated on learning a technology, it is not using technology in mathematical context. "The use of technology in mathematics teaching is not for the purpose of teaching about technology, but for the purpose of enhancing mathematics teaching and learning with technology." (Garofalo et. al. 2000:68) The significance of availing the Internet resources is not chiefly to be adept at navigating the web but predominantly to initiate and demonstrate its usefulness in understanding the mathematics. Hence, in Algebra 1, drawing on the *general* features of Geogebra online helps students absorb the concept of linearity by creating a movable graph that shows them the factors affecting the changes and what these modifications do to the equation. In this manner, the mathematical content drove the use of technology and not the other way around.

Meaningful mathematics does not rely on computational proficiency alone, it inculcates making sense of particulars to get the whole picture and then, evaluating its viability in various situations. "Content-based activities using technology should address worthwhile mathematics concepts, procedures, and strategies, and should reflect the nature and spirit of mathematics." (Garofalo et. al. 2000:69) So, from grasping the idea of linearity by manipulating graphs and equations, the students can venture into the realm of *environment* applications. The video vignettes relevant to linear modeling on the web such as the Jasper Project pose issues in real-life settings in which the teacher is the facilitator and the students play the experts' roles by applying their mathematical skills in solving the conundrum. In this way, the known mathematical content on linearity is intertwined with the pedagogy while the technology is a medium that extends the mathematics into their lives. This certainly proves, "students should experience the [natural] process of mathematical" explorations. (Blubaugh. 2009:41)

Taking advantage of technology does not insinuate utilizing it even if the mathematics can easily and efficiently be performed with metacognition, with paper and pencil, or on the whiteboard. Instead, "activities should take advantage of the capabilities of technology, and hence [technology] should extend beyond or significantly enhance what could be done without technology." (Garofalo et. al. 2000:71) Going further than discerning linearity with the *general* and *environment* programs, the *review and practice* attributes of certain virtual manipulatives can be practical. Returning to the National Library of Virtual Manipulatives, linear equations can be represented with tiles via its segment called "Algebraic Tiles." As a supplement to foiling binomial linear equations, the students can now see before them how equations such as x  (y + 2), which is read as "what is x groups of y plus two things" looks like. From here, they can pair and add the tiles to get the solution. (Figure 6) Furthermore, with more complex binomial linear equations, the students will find it faster than foiling. In this fashion, technology made visualizations available when it can't be possibly done fast and effectively with analog instruments or by pure imagination.

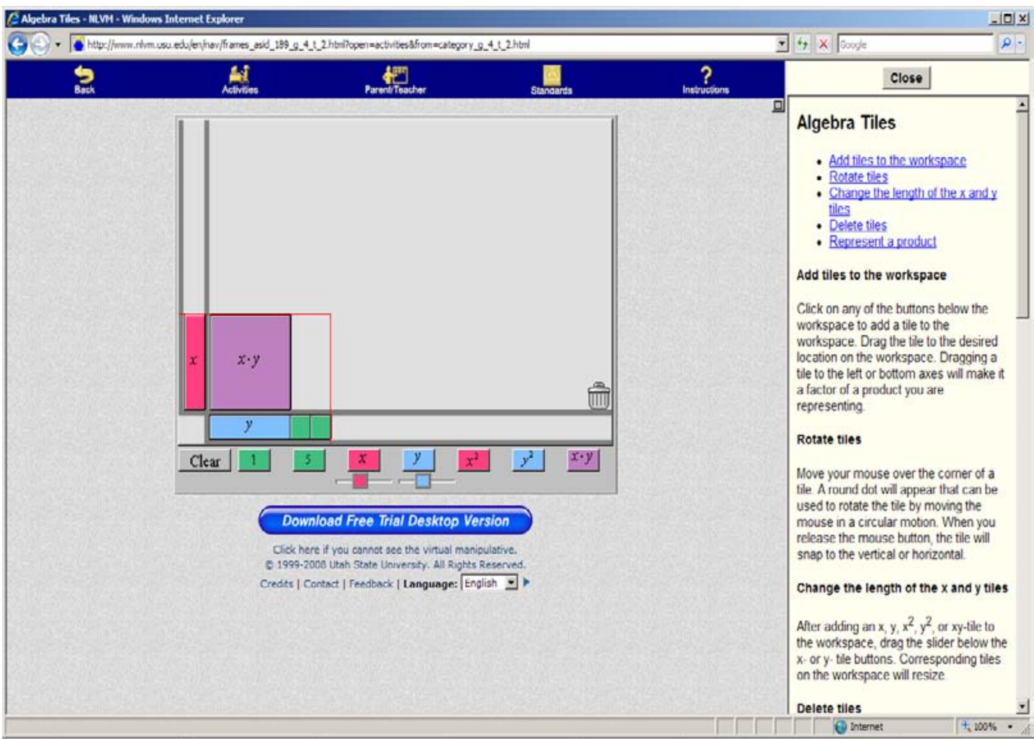



**Figure 6.** *NLVM Algebraic Tiles.* Shown is ***x (y + 2)*** with part of the solution done: the ***purple xy*** tile is in place for multiplying the ***pink x*** tile with the ***blue y*** tile. What are the missing tiles?

Isolating each branch of mathematics and treating mathematics as a study of its own do not constitute meaningful mathematics. "Technology-augmented activities should facilitate mathematical connections in two ways: (a) interconnect mathematics topics and (b) connect mathematics to real-world phenomena." (Garofalo et. al. 2000:73) Having attained knowledge, application, and analysis through *general, environment,* and *review and practice* designs, it is significant to mention Fathom, a *specific* program that also extends Algebra 1's linear concept to data analysis in another area of mathematics, which is statistics. As previously demonstrated, the sample collected on the concentration of oxygen to determine its effect on water temperature is one of its linear modeling activities. In this paradigm, the cognition of mathematics is brought up to the juncture of synthesis: interrelating algebra, statistics, and science. The entirety links distinct topics in mathematics with true-to-life conditions.

It is not enough to solve word problems with algebraic maneuverings. A fundamental consideration is to connect "the verbal, graphical, numerical and algebraic representations of mathematical functions;" then, "move to a digital environment with numerical, graphical, and geometrical representations and finally use a paper-and-pencil algebraic representation and symbolic manipulations to confirm the relationship." (Garofalo et. al. 2000:77) Since the guidelines for using the different types of Internet resources are intertwined, a combination of several rules and types or the feasibility of all these methods can draw out mathematical relevance depending on the content and pedagogical needs. Likewise, in understanding Algebra 1's linear concept: the *general* application afforded graphing, manipulation and discovery; the *environment* design paved the way to metacognitive tasks in dissecting what is known and unknown; the *review and practice* made linear equations imaginable and the *specific* program connected linearity with other topics in a tangible situation. In all these circumstances, expressing ideas is a vital element. Thus, a *communication* medium online is another technique to collaborative representation of mathematical thinking. All the while, linear concept is being represented and related in multiple perspectives.

Strengths and Limitations

Using technology's Internet resources has its strong points. The cost is offset by the tremendous amount of teaching and learning materials, which provide opportunities that otherwise, can be pricey. Handheld manipulatives and outdoors explorations can be expensive depending on materials, manpower, and locations contrary to the free virtual tools and places that students can avail of. Corollary, convenience comes to play by bringing students to "virtually any time or place, delivers illustrations of activities that to witness in person would be unsafe or unaffordable, and enables students to view…events" without leaving the secure haven of the classroom. The extensions imparted refer to the vast and seemingly infinite access to libraries of data in the United States and around the world. Furthermore, with prudent use of the web, adaptations to various learning backgrounds and styles are readily accessible. Pacing is consequently an essential character. The immediate feedback allows students to adjust their speed of learning and thus, progressively moves them to advance levels with ease. The learning duration then, is reduced "by an average of 50%". Adding to these, equity is accomplished with the flexibility it renders to differentiated instruction. As for the flow, there are more or less steady and consistent lessons without the frailty of exhaustion and the fallibility for errors. (Lookatch. 2009:online)

Conversely, there are challenges to using the Internet resources. Costs include the hardware and software maintenance and updates as well as the skilled labor. A saving tip can be found in the judicious choice of software. Opt for established freeware or reputable softwares with minimum fee for the least upkeep. Since virtual space is not a substitute for hands on experiences and for the actual encounter, combining both is economical yet effective. On the lack of human interaction on the individuality of self-paced programs, differentiated grouping for live interface can be an added bonus. If library web search becomes overwhelming, advising students to visit the library to check out particular references is a relief. As for the propensity to be less in depth on learning quickly with technology use, classroom content and pedagogy must be the impetus for its usage. When considering the volatility of technology, which is moments of glitches, the teacher should always have alternative plans and should have printed out worksheets or downloaded the materials ahead of time. Despite these restrictions, technology's Internet resources can work for you by committing to memory the methodical strategies in making insightful decisions on their appropriate uses. In the end, the benefits still outweigh the limitations.

Algebra 1's Linear Modeling with Internet Resources

Equipped with the facts on methodical strategies as well as the benefits and constraints of employing technology's Internet resources, modeling Algebra 1's linear concept through a specific mathematical problem is a noteworthy demonstration. Surfing for an Internet material led to the linear modeling that involves the relationship between the number of oil changes per year and the cost of engine repair (http://illuminations.nctm.org/LessonDetail.aspx?id=L298).

| Oil Changes Per Year | 3 | 5 | 2 | 3 | 1 | 4 | 6 | 4 | 3 | 2 | 0 | 10 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cost of Repairs ($) | 300 | 300 | 500 | 400 | 700 | 400 | 100 | 250 | 450 | 650 | 600 | 0 | 150 |

Oil Changes and Engine Repair

A customized worksheet [I created] based on the aforementioned web resource is presented to the students to guide them through the activity. The initial step is getting acquainted with the given data. This activates the students' thought processes.

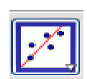
## **Know** About It (Getting Acquainted with the Data)

1. What are the variables on the data?
2. Which of the variables is the independent data? Why?
3. Which of the variables is the dependent data? Why?
4. How would you label the axes? In what increments?

With the content serving as the impetus to technology use, Geogebra is the preferred *general* online program for visualization because it is convenient, established, and free. As they plot the data points and figure out the *best* fitting line following the questions in scaffolding approach, the students discover the relevance of the graph. This is a corroboration of technology's Internet resource at work.

## **Visualize** It (Graphing the Data)

Using the Geogebra freeware from the Internet and do the following:

1. Plot the points with 
2. Create the *best* fit line with . It should be the line you believe fits the plotted points.
3. Answer the following questions:
   - Is the slope positive or negative? How do you relate this slope to the variables?
   - What does a unit represent on the x-axis? On the y-axis?
   - How do you determine the slope of your *best* fit line? (Hint: Either look at Geogebra's Algebraic View or pick two points on the *best* fit line.)
   - After getting the slope, what is the change in the cost of repairs for each oil change?
   - What are the intercepts? What do each intercept signify?

In drawing out the effective use of this technology, it makes pedagogy worthwhile by concretizing the abstract in multiple representations as it makes the content meaningful with real conditions and purposeful tasks.

## **Symbolize** It (Representing the Data with Algebra)

1. Write the equation of the *best* fit line in standard form? Explain what this equation indicates?
2. Transform it in slope-intercept form. What does this equation mean?
3. Pick a point that you can prove that it's on the line algebraically. Either form can be used.

## **Reflect** It (Understanding the Data)

1. What do the data points above the *best* fit line signify? How about those below the *best* fit line?
2. What are the possible reasons for the deviations on the line?
3. Is the number of oil changes per year the sole factor on the cost of engine repairs? Make your conclusion.

Therefore, in Algebra 1, taking advantage of the Internet resources judiciously provides opportunities to know the word problem, visualize the imaginary, represent the facts, and understand them by linking various outlooks to get the mathematics, assimilate it, and make use of it.

## Conclusion

One of technology's powerful educational depots is the Internet. Recognizing the types of softwares or applications: *review and practice*, *general*, *specific, environment,* and *communication,* and bearing in mind the guidelines for their use: *introduce technology in context, address worthwhile mathematics with appropriate pedagogy, take advantage of technology, connect mathematics topics,* and *incorporate multiple representations*, enhance mathematics learning as they engage the students and facilitate the retention of the concepts in mathematics.

The gains in integrating technology on the aspects of cost scale of economies, adaptability, consistency, convenience, ease, equity, and scope prevail over its restrictions, which are not in any way impossible to overcome. The valuable insights to the nature of technology within the dominions of mathematics bring dynamic means for progressive mathematical minds.

# References

Articles

Blubaugh, W. L. (2009). A course for pre-service mathematics teachers that focuses on mathematics and the integration of technology. *Mathematics and Computer Education*, 43(1), 41-46.

Bunch, Bryan. "Algebra." The New Book of Knowledge®. 2009. Grolier Online. 31 Mar. 2009 <http://nbk.grolier.com/cgi-bin/article?assetid=a2000630-h>.

Koehler M. and Mishra P. (2008). Advancing TPCK through collaborations across educational associations. *Handbook of Technological Content Pedagogical Knowledge (TPCK) for Educators*, New York: Routledge.

Lee J. (2008). Advancing TPCK through collaborations across educational associations. *Handbook of Technological Content Pedagogical Knowledge TPCK) for Educators*, New York: Routledge.

Garofalo, J., Drier, H., Harper, S., Timmerman, M.A., & Shockey, T. (2000). Promoting appropriate uses of technology in mathematics teacher preparation. Contemporary Issues in Technology and Teacher Education, 1(1), 66-88.

Kastberg, S., & Leatham, K. (2005). Research on graphing calculators at the secondary level: Implications for mathematics teacher education. Contemporary Issues in Technology and Teacher Education, 5(1), 25-37.

Kurz, T. L., Middleton, J. A., & Yanik, H. B. (2005). A taxonomy of software for mathematics instruction. Contemporary Issues in Technology and Teacher Education, 5(2), 123-137.

Lookatch, Richard P. "Education: Instructional Technology." Encyclopedia Americana. 2009. Grolier Online. 22 Oct. 2009 <http://ea.grolier.com/article?id=0432787-00>.)

<u>Webpages</u>

www.nlvm.usu.edu

www.geogebra.org

http://www.keycollege.com/ws/Fathom/datafiles.html

http://peabody.vanderbilt.edu/projects/funded/jasper/preview/AdvJW.html

www.mathforum.org

http://illuminations.nctm.org/LessonDetail.aspx?id=L298