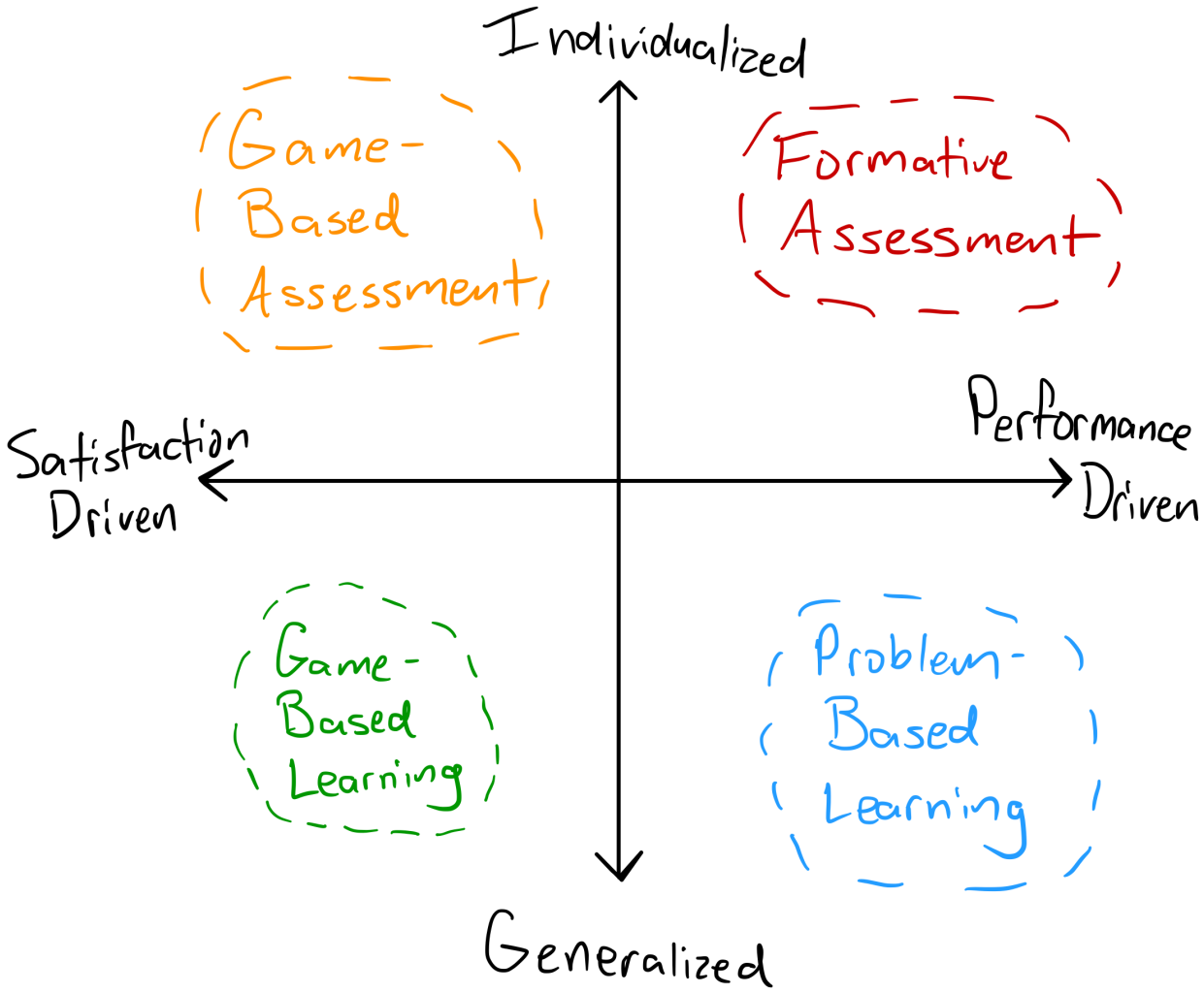
Donovan McMurray
CS6460 Educational Technology
Assignment 2 – 2017.09.03

"Education is not the filling of a pail, but the lighting of a fire."
–William Butler Yeats

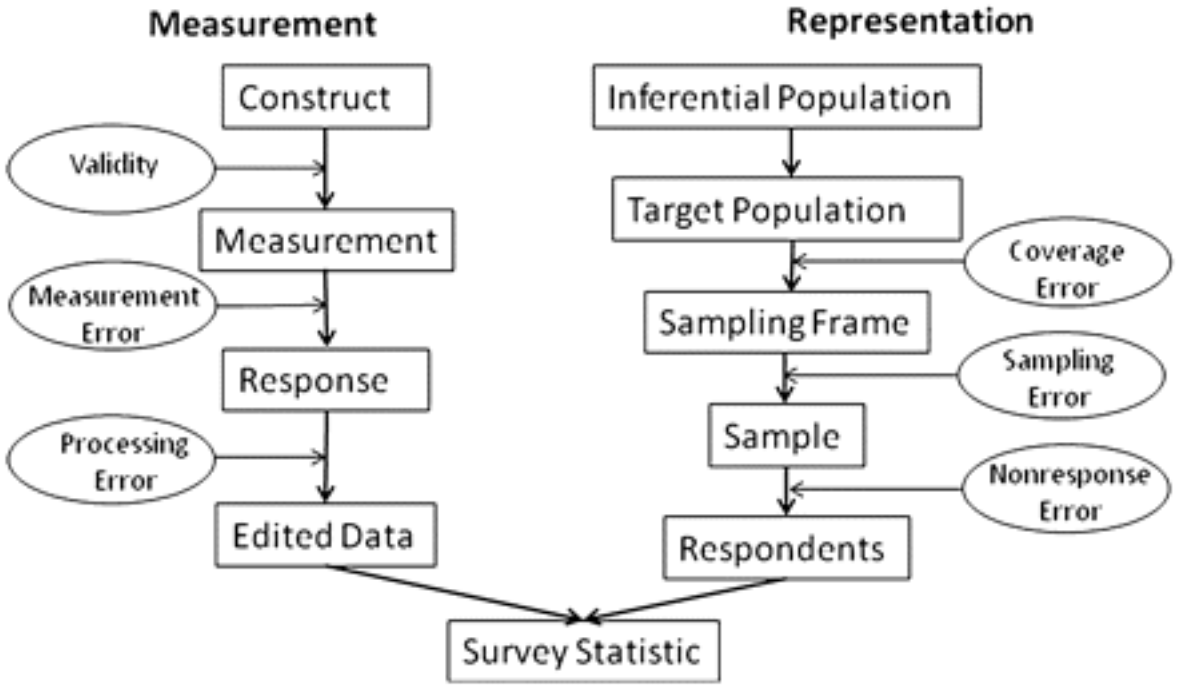
As I started delving into the world of educational technology research, I found myself drawn to works that had the above Yeats sentiment close to their core.[1] The qualities I associate with Yeats' quote are student engagement, motivation, enthusiasm, satisfaction, and performance. These qualities began to form into the following diagram, where the "center of mass" of each domain falls on two axes: Satisfaction-Driven versus Performance-Driven and Individualized versus Generalized.



For example, Game-Based Learning research typically doesn't adapt to an individual player. Most people are familiar with the original Super Mario Bros for the NES, and though it's not an educational game, it's illustrative to my point. While on the surface this game seems dynamic, it doesn't increase the difficulty of the next level if you finish the current level very quickly, and it doesn't introduce more Koopa Troopas if it notices that a player has particular difficulty in dealing with them.

Game-Based Learning

The National Foundation for Education Research found that Game-Based Learning suffers from many of the same problems as Computer-Aided Instruction research suffers from in general: specifically, having mixed results and studies using questionable research methods around measurement and representation.[2][3]



Furthermore, it's possible that trying to teach with games could actually negatively impact students' motivation by training them to be externally motivated toward educational endeavors.[4] However, games are a perfect vehicle for the Yeats quote I related to so much, so I wondered if there was any hope for this teaching methodology.

Amy Bruckman challenges ill-advised and half-hearted attempts at gilding education with a thin veneer of fun in the opening line of her paper, saying "Most attempts at making software both educational and fun end up being neither. Fun is often treated like a sugar coating to be added to an educational core. Which makes about as much sense as chocolate-dipped broccoli."[5] She offers some practical advice from the schools of

though of Constructivism/Constructionism on how to avoid this trap and make educational games that are actually useful. Her advice is

1. Make the learning inherently fun – don't sugar-coat an unpleasant educational core.
2. Put learning in context.
3. Open-ended tasks are more engaging and promote creativity.
4. Learning by making things is one useful approach that is both fun and educational.
5. Whenever possible, provide social support for learning.

This advice sounds perfectly in line with Microsoft's *Minecraft: Education Edition*, which seems like a very promising avenue for further research in this domain.[6]

Problem-Based Learning

Where game-based learning fails to win over critics by not being focused enough on results, problem-based learning (PBL) approaches the problem from a performance angle at its foundation. PBL aims to be a closer approximation to "real-world" problem solving, helping students "achieve higher levels of comprehension, develop more learning and knowledge-forming skills and more social skills as well."[7] The principal investigator on the Pew grant, John Cavanaugh, puts PBL into context with other types of learning by the following subset relationships:

$$\text{PBL} \subset \text{Cooperative/Colaborative} \subset \text{Active Learning}$$

Using current research on knowledge transfer (the ability to apply previous knowledge to novel circumstances), Kolodner, et al., developed Learning By Design™, which is a curriculum centered around case-based reasoning and PBL research, combined with engaging projects and classroom management guidelines.[8] Some example projects from their physical science unit asks the students "to design and build a parachute (to learn about combining forces), to design and build a miniature car and its propulsion system so that it can go over several hills and beyond (to learn about forces and motion), and to design and build a device that can lift a heavy object for someone with a disability (to learn about mechanical advantage, work, and simple machines)."

Even though I've framed PBL as "performance-driven" (because that's the motivation), it actually does have a high satisfaction rating for students as well. This is a byproduct of the work feeling meaningful instead of work that induces the common refrain, "When will we ever *use* this?" PBL achieves this goal by "[giving] students a sense of ownership over their learning, [developing] relevant and meaningful problems and learning methods, and [empowering] students with valuable skills that will enhance students' motivation to learn and ability to achieve."[9][10]

Many of the examples in PBL are non-digital projects, and most of the projects that I saw were the physical sciences. I am curious if these methodologies can be adapted to more abstract subjects, and if the projects can be on a computer, perhaps using some of the techniques within game-based learning in order to engage students further.

Formative Assessment

Learning cannot be evaluated if it cannot be measures, so assessment is vital to a quality learning system. Assessment can be broken into two types: formative and summative.[11] Summative assessment is the kind most people know. Testing, exams, piano recitals, and any other kind of final evaluation falls into this category. Formative assessment, on the other hand, is a monitoring that teachers can use to improve and tailor coursework to individual or groups of students.

A sweeping research review of 250 sources by Black and William found that emphasizing formative assessment in the classroom has a statistically significant positive effect on later summative assessments of students, with the largest gains going to struggling and learning-disabled students.[12][13] Not only does formative assessment allow teachers to focus on students' problem spots, it also informs the students themselves what areas need special attention. Furthermore, in a social learning environment, other students can administer the formative assessments, raising the performance of each student involved.

Game-Based Assessment

Formative assessment can apply to digital systems as well. One interesting area of research I found was Game-Based Assessment (GBA).[14] GBA can inform both student and teacher formative assessments. For further research into this area, I'm interested in reading the book *Technology and Testing: Improving Educational and Psychological Measurement*, which goes into great detail about frameworks for designing GBAs and how they can make testing – and subsequent individualized learning – fun.

References

[1] http://www.newmedia.org/game-based-learning--what-it-is-why-it-works-and-where-its-going.html

[2] http://ocw.metu.edu.tr/pluginfile.php/10919/mod_resource/content/1/GAME01.pdf

[3] https://academic.oup.com/poq/article/74/5/849/1817502/Total-Survey-Error-Past-Present-and-Future

[4] http://www.alfiekohn.org/punished-rewards/

[5] https://www.cc.gatech.edu/~asb/papers/bruckman-gdc99.pdf

[6] https://education.minecraft.net/

[7] http://www1.udel.edu/pbl/deu-june2006/supplemental/NTLF-PBL-introduction.pdf

[8] https://stemedhub.org/resources/800/download/Kolodner_etal_2003_PBL_Meets_Cased-Based_Reasoning.pdf

[9] http://web.stanford.edu/dept/CTL/cgi-bin/docs/newsletter/problem_based_learning.pdf

[10] http://onlinelibrary.wiley.com/doi/10.1002/tl.7805/full

[11] https://www.cmu.edu/teaching/assessment/basics/formative-summative.html

[12] http://pareonline.net/getvn.asp?n=9&v=8

[13] https://kclpure.kcl.ac.uk/portal/files/9119063/Black2009_Developing_the_theory_of_formative_assessment.pdf

[14] https://books.google.com/books?hl=en&lr=&id=dM1mCgAAQBAJ&oi=fnd&pg=PP1&dq=education+technology+testing&ots=apP34i9N63&sig=Olw5hO9uRFV_ujRpW3ZXyVCFe14#v=onepage&q=GBA&f=false