# From Quantified Self to Building a More Fit Community: Data Tracking and Science Infographics as Boundary Objects

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**Abstract:** This design case study considers one teacher's use of two socio-technologically enhanced supports to promote students' thinking across boundaries. Quantified self biometric tracking technology is used to capture data related to students' physical experience while an infographics authoring activity is utilized to afford students making sense of these data, synthesizing disciplinary knowledge, and ultimately producing public knowledge artifacts for their communities. The designed integration of these technologies allows and demands that students connect their personal experiences to disciplinary ideas and practices as well as to an audience of their local school community.

## Introduction and purpose

This design case study considers how student generated infographics can be incorporated into content driven, formal learning spaces as tools to cross disciplinary boundaries, incorporate students' experiences, and authentically engage communities. During a ten-week health and fitness class, high school students used an ensemble of technologies to record and catalog their own physical fitness, engage with new content knowledge and generate a series of their own science news infographics that related their findings and claims to the larger school community. Infographics are multipart visual representations of complex data and concepts that present scientific data, ideas, and arguments to an audience. Student generated infographics became artifacts that served as boundary objects that encouraged students to reflect on and synthesize their own experiences, build disciplinary knowledge, and express their agency and capacity to affect change in their communities. In this Fitness for Life (FfL) class, students gathered biosensor and self-report information, particular kinds of quantified self (QS) data, as an entry point for understanding and reflecting on their everyday practices related to fitness and health. Simultaneously, students integrated and synthesized disciplinary content knowledge related to biology, health, and mathematics to produce a series of 'public service announcement' infographics with data visualizations geared towards various community audiences.

The FfL course is one of many classes that are part of our broader project, STEM Literacy through Infographics (SLI), that considers how to best design learning environments to foster students' STEM (science, technology, engineering, and mathematics) literacy in an era of a vast amount of data presented in a multitude of representational forms. We are concerned with how the use of technology and various representational modalities can bolster student self-reflection, discourse, and learning across disciplinary boundaries. In this paper, we examine how this teacher adapted a general model for infographics integration to include quantified self data. The course was designed to make visible students' everyday experience, consider these QS data in relation to new disciplinary content knowledge, and ultimately synthesize their multi-dimensional learning to make predictions about their own future health and recommendations for a public audience.

## Theoretical framework

The SLI project is driven by a socio-culturally informed design principle of "contextualizing science in life" (Polman, Gebre, & Graville, 2014). We encourage teachers to invoke students' own experiences, make connections across disciplinary boundaries, and challenge students to communicate complex ideas to a variety of public audiences in multiple contexts. Student generated infographics serve as mediating artifacts (Wertsch, 1998) that allow for presentation, synthesis, and integration of multiple forms and sources of knowledge. In this sense, the infographic artifacts allow students to span various boundaries, disciplinary or otherwise. As there continues to be increased specialization in disciplinary knowledge, *boundaries* manifest as what Akkerman & Bakker (2011) call "socio-cultural differences leading to discontinuity in interaction or action" (p. 152). Such boundaries not only divide disciplinary knowledge, but also divorce students' lived experience and out of school learning from classroom content. We see student generated infographics serving as *boundary objects* that cut across social worlds and sites of discourse, or otherwise enable bridging (see also Polman & Hope, 2012). These sorts of boundary objects inhabit multiple worlds and become grounding artifacts where multiple fields of inquiry or practice can interact. Infographics as boundary object allow for students to dialogically hybridize and engage multiple fields of knowing in discourse (Akkerman & Bakker, 2011). As a result, boundary crossing can lead to increased student agency, new forms of community engagement, and ultimately transformation.

Transformation may occur as students identify their own positioning across several domains and coordinate diverse perspectives, experiences and ideas through communicative connection and translation.

The framing of infographics as mediating artifacts and boundary crossing objects pairs nicely with a growing interest in and access to the 'quantified self' (QS) movement in educational technology and design. QS involves 'extended tracking and analysis of personally relevant data' (Lee, 2014, p. 1032), that is innately interesting to active learners (Moher et al., 2014). While many initiatives intended to teach students data literacy primarily focus on accessing and understanding large existing data sets (Hammerman, 2009), QS interventions draw on students' authentic, lived experience as primary source material for analysis. Data collected through analog practices like journaling or technologically enhanced means such as wearable devices often reveal patterns and phenomena about one's own embodied experience that are otherwise not visible. These sorts of socio-technological systems can be used to support knowledge building and knowledge sharing in highly participatory learning environments integrating multiple dimensions of knowledge (Lee, 2014). Scientific ideas derived from instruction, QS data from students' own bodies, and knowledge from other classes each serve as individual 'inscriptions' of student experiences (Latour, 1990). By curating and organizing these various inscriptions into a cohesive visual argument, students can use infographics to represent an accumulation or cascade of inscriptions, mobilizing multiple knowledges that transcend established boundaries.

## Research context and methods

Data for this analysis are primarily drawn from one teacher's reflection on the design and implementation of her course, supplemented by other artifacts. We consider three structured interviews with the instructor Abby (a pseudonym), her course planning materials, two observational field notes, and the student generated infographics that happened in four cycles. The analysis here is a case study of the designed learning environment and the teacher's perspective of how the course provided opportunities for and demands for students to develop their thinking and ideas.

The Fitness for Life course was designed by Abby in the fall of 2016 after she attended a weeklong professional development regarding integrating data literacy and infographics into the classroom. The course took place at an ethnically, socioeconomically and geographically diverse, residential high school in the intermountain West of the United States designed for students that were not finding success in traditional school settings. Five students participated in this ten-week class that met for forty sessions, each lasting 2.25 hours. Abby's initial course proposal outlined student learning objectives including "Learning about their own bodies and how to take ownership of their health...[to] connect this to the real world," and "predict how their diet and exercise habits will influence their future lives." Abby designed the course to be interactive, multi-disciplinary, and draw on variety of student funds of knowledge. Abby noted, "I don't really think you can engage in understanding about our bodies, fitness, or health without understanding at least some level biology and math."

## Case study findings

Abby's curriculum and design activities were enhanced through two socio-technically supported mediating systems; infographics and technology to track biometric data. Student generated infographics were integrated into the curriculum as platforms for students to synthesize content knowledge and their own lived experiences into tangible artifacts that would be shared with community members. Abby reflected, "When I went to the infographics [professional development] institute, it was like a light bulb ... infographics are this perfect vehicle to teach them things about how to make a graph and y=mx+b and p-values, and then how to relate that to the biology we learned in class, and how does that relate to community ... and to see how they are integrating all of these things." Four cycles of infographic activities (Table 1) were built into this class.

Table 1: The four cycles of infographic assignments in the Fitness for Life class

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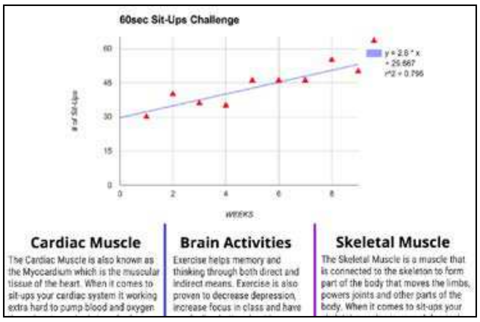
| Content | 5 elements of fitness (Week 1) | Obesity & Fitness (Week 3) | Open Choice (Week 6) | Synthesis of Class & QS Data (Week 10) |
| Audience | Instructor | Youth | Adolescents | 'future self' & school |
| Data Source | Class Syllabus | instruction on biology & health | instruction on biology, math & public health | 10 weeks all instruction & biometric data |

Abby also designed the class so that students would track their own biometric data throughout the semester in analog fashion and with technologically supported systems. Students kept daily written logs that tracked things like the amount of sleep they got, general mood, and specific logs related to exercise routines (e.g., number of sit ups, push ups, or times for cardio events). In addition, each student was issued a FitBit to track biometric data from the beginning to the end the semester. She explained that students, "don't realize we are tracking data about our life or making predictions for the future, I think we just do it automatically and I try and teach my students to do it explicitly as there is an inherent math component at being good at doing fitness."

Each of the four units culminated in the production of a student created infographic artifact geared for a particular audience. The first week students completed an introductory infographic to become familiar with the online design canvas and recognize the five elements of fitness that would be covered in the class. For the next unit covering childhood obesity, the expectation of providing a visually appealing, scientifically relevant argument by way of a public service announcement infographic was paramount. Abby explained "They are asked to create an infographic that would be appealing to the child, like real colorful... but it would also be informative for the parent who is making a decision about how to help [their] kid stay healthy." Here, students did not simply demonstrate comprehension of content knowledge, rather they used this information to form persuasive arguments towards a real audience. In the third unit, students could choose their own topic so long as it related to adolescent health. Students were to 'pick a position and convince' their peers of a fitness related topic. Examples included the dangers of steroids, importance of stretching, strategies for increasing muscle mass, etc. The final project required that the students somehow integrate the quantified self-data they had gathered over the ten weeks with the interdisciplinary content they had learned in class. Abby explained, "So the idea is for them to see this change over your body, and you have hopefully learned enough biology and math to say why these changes take place. And what was happening inside your muscles or lungs that made your heart rate decrease? And how does this relate to the information you learned? And what is your plan for the future? And how does this relate to other community health concerns?" Figure 1 shows an excerpt of a student infographic that uses the calculated slope of her fitness gains to make predictions about her future performance and various aspects of her changing health. These final infographics that synthesized students' own habits, content knowledge, and community recommendations were then displayed in the school gym and student findings were shared at their end of semester school wide oral presentations.

Abby structured the FfL class around a school learning objective of 'creating healthy life choices.' For her, this required much more than students simply understanding disciplinary knowledge related to health, biology, or mathematics. Her goal was for students to make informed decisions about their own practices, set goals for the future, and be able to offer informed opinions to their peers and community members. She explained, "The theory was to take this individual information, like I saw this happen to *me* and then relate it to scientific knowledge, and then relate it in a way that would somehow be beneficial to the community." The quantified self data helped reveal students' own routines while the infographics served both as a platform for personal synthesis and integration, and also as a medium to communicate interdisciplinary knowledge to a broader audience. In this sense, these technologies helped students cross several boundaries (see Figure 2).



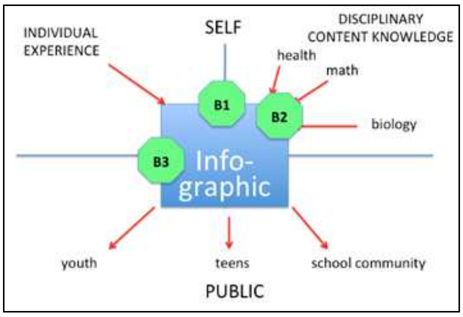




Figure 1. One excerpt from a student generated infographic tracking change in fitness and health over time.
Figure 2. The infographic serves as a mediating object to assist in at least three distinct boundary crossings.

The first boundary students in the FfL class crossed (B1) concerns a distinction between individually enacted experiences and disciplinary content knowledge. From the very start of the course students completed daily health and fitness logs and were encouraged to wear FitBit devices 24/7. Through this analog and technologically supported tracking, students' individually enacted practices began to be made visible by way of 'raw' or unprocessed data (e.g., spreadsheets with quantities). Yet, despite these data being 'visible' by way of recording and display, the data lacked meaning in that they were not yet directly tied to the learning students were doing in the FfL course nor were patterns obvious. Through classroom instruction, Abby hoped that students would be enabled to draw connections between the math, health and biology content represented in their own quantified self-data. She explained, "I really hoped [the infographic] would be a platform that the students could use to integrate and then showcase their knowledge... This is about real life, not just a class. And if you drill down to that base level, you have to be interdisciplinary." The quantified self data made visible students own daily practices and through the mediation and synthesis afforded by the infographic authoring, students were challenged to integrate this knowledge with the disciplinary content provided through instruction.

The second boundary crossing (B2) concerns the distinction between academic disciplines themselves. Often increased specialization, particular methods, or isolated literatures prevent integration of content knowledge across disciplinary boundaries (Akkerman & Bakker, 2011). By design, Abby worked to provide platforms for students to synthesize and integrate multiple forms of knowing drawing from math, health, and biology. The quantified self data provide personalized numerical fodder for analysis while infographic authoring affords a space to synthesize. She explained, "[The infographic] let me see how the person is relating to this knowledge...so it is really interesting for me as an instructor, from a formative and then summative perspective, to see how they are putting things together." Students do not simply demonstrate competence in one scholastic discipline, instead they are challenged to use the infographic to synthesize different content knowledge into a coherent argument for a specific audience or to make predictions for their future selves.

The third boundary crossing (B3) in the FfL course concerns a move from individual knowledge comprehension to public engagement in the students' communities. Abby explained that each student considered and was motivated by the fact that their final products would be printed and displayed around their school space. She explained that she did not want students to "just type up a paper, like some boring rote thing," but instead create a visual artifact that would have some immediate effect in the school community. She was surprised that after students completed their final products, they requested that they could hold a non-required school gathering to share their findings with peers and staff. In fact, the students had calculated predictions about the change in overall fitness of the campus population if new protocols were enacted regarding where the buses regularly parked. If the buses stopped further down the hill, students predicted that their peers may lose 1.5 pounds over the course of a semester. As students' awareness of their fitness crossed personal and disciplinary boundaries, the teacher saw their agency and desire to affect change in their lives and communities as increasing.

## Conclusion and significance

This case study of the Fitness for Life class design demonstrates how a teacher working across disciplinary and spatial boundaries can invite student synthesis and integration of multiple forms of knowledge. The inclusion of quantified self (QS) data as primary research fodder and the use of infographics as mediating artifacts that span boundaries grounded learning in students' own experience and expanded this to public engagement. QS tracking made visible students' tacit fitness habits as raw data, the integration of design synthesizing content knowledge added meaning to these data, and the production of public facing infographic artifacts challenged students to communicate their findings as scientifically sound and persuasive claims to affect positive change across existing boundaries. This variety of socio-technically enhanced learning originating in students lived experiences and realized in public expands the use of QS educational technology beyond the individual and invokes community as a way to drive engagement and learning. Future socio-technically enhanced learning interventions may benefit from designing learning environments around the use of cascading inscriptions that draw on students' authentic experience and incrementally build towards public engagement.

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