Analyzing Meaning in Model Construction through Multimodal Data

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Abstract
This paper briefly outlines the use of multimodal data to measure how middle school participants learned about biology content through the construction of model-making. This includes a look at various data channels and how gaming scholars can move away from exclusively examining discourse or clickstream data in favor of creating an environment where children can be producers of their own work. The creativity produced by these participants underscores the excitement middle schoolers have in developing their own work and the rich diversity surrounding model construction. Here, the author reflects on the current state of analyzing model construction and possible ways to merge data channels in the future to create a more authentic picture of learning.

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Big data, gameplay, model construction, biology content, discourse

ACM Classification Keywords
B.3.2. Design Styles, B.7.2. Design Aids, I.3.6. Methodology and Techniques

Introduction
Informal learning environments create a unique opportunity for children to construct and produce new material in ways that cannot always be leveraged within a classroom environment [1]. Games-based learning, and the coordination of participatory cultures in relation to gameplay experience, affords users the chance to formulate new ideas and reciprocate information back for new members to better understand. From playing commercial games to creating games from scratch, this field is opening in ways previously unimagined [2] [3].

The question becomes this: how can researchers interested in games for learning target and extract meaningful experiences using data, particularly in the way of model construction? At present, games-based research is frequently situated in clickstream data, user experience, or pre/post gains. More rarely do scholars merge qualitative and quantitative data streams together in order to develop a more authentic picture of what students are doing during the gameplay experience. Given this, how can we move away from

analyzing just discourse data in favor of adopting a wider range of semiotic resources while creating an environment where children are encouraged to be producers of self-driven work?

The purpose of our study was to bridge the methodological gap by merging qualitative and quantitative data streams together in order to better capture how children play within an informal learning environment. The ability to analyze "big data" [4] in ways that create meaningful inferences is a major task, one that our team continues to tackle. This paper seeks to reflect on our experience of situating big data in order to understand how children become makers and scientists during sessions of play.

Curriculum

The curriculum was set over a five day period. Each participant role-played as a scientist recruited by members of the Center for Disease Control to stop a fictional virus from spreading. Our team divided participants into teams of 3-4 for small group activity. In small groups, participants played Virulent and constructed models of virus and immune system behavior, and revised these models following gameplay.

The activities took place as follows: on Day 1, participants played the game and wrote letters to the CDC. On the second day, they began model construction and continued gameplay. On the third day, model construction and gameplay continued, along with a video script to the CDC. The fourth day consisted of peer presentations. On the final day, participants came together to debate the best strategy for stalling the fictional virus. A cohort vote determined which of the three options would best stall the virus: a vaccine, an RNA inhibitor, or the removal of mitochondria from the body's system.

Data Collection

Our team collected discourse across each day using small USB recorders that were provided to each and every participant. Our team also documented and photographed the construction of models. Other channels, including clickstream data, captured our participants movement as their character journeyed across the level [5].

Data Analysis

All audio was cleaned and sent for transcription. Discourse was uploaded to MAXQDA for coding. Various coding structures were used to trace themes, including an argumentation framework [6]. Inter-rater reliability was established for each theme and 30,000 turns-of-talk were coded across the data corpus.

Demographics

A total of 86 participants across 3 cohorts were enrolled in our program. The average age of participants was 11.5 years and the majority identified as White Non-Hispanic (N=37) or African American (N=18).

Early Challenges

Our team focused exclusively on pre/post assessments and clickstream data during the preliminary stage of analysis. These data channels were "low hanging fruit" and therefore easy to decipher. However, the quantification of this information did not provide insight into the social activity, environment, or co-design of artifacts. Our team subsequently turned to hand-coded discourse, which required a longer time and effort due to the numerous lines pulled from the audio. This

process has taken roughly 2 years to complete. In doing this, the production of models and videos fell to the wayside. The decision to forgo model analysis was not because children as makers of work are not appreciated. However, within our interdisciplinary team of experts, the idea of "making" was not prevalently discussed. Here is where the question of analyzing quantifiable data, or quantifying data from the production of items made, comes in.

Children as Producers

The construction of models was peer-driven and required children to freely investigate the game without having to conform to specific definitions or terms. The creation of models was dependent on the coordination of multiple artifacts, backgrounds, and shared experiences with gameplay. In some cases, students chose not to use paper and pencil to showcase the relationship between virus and immune system behavior, but to create "interacting parts" whereupon a constructed virus is moved through a tunnel and away from slicer enzymes. Other representations included a comic strip and a "movie style" model. Figure I provides a look at a group's construction of virus and immune system components using pipe cleaner, glue, and construction paper. These components were later taped to a model as each group member took their turn explaining its relationship to the virus/immune system.

Figure 1: Model Construction during Day 4

The creativity produced by these participants underscores the excitement middle schoolers have in developing their own work and the rich diversity surrounding model construction. However, our team has not considered ways of merging model construction with discourse, or model construction with telemetry data. These challenges may continue to be a barrier as we move forward. Right now, the question of whether video presentations and photography are *enough* to analyze data is contingent on numerous factors, such as finding meaningful ways to analyze co-design.

Discussion and Conclusion

The construction of models to represent virus and immune system behavior is promising. However, the construction and use of models is hard to track and interpret, particularly when merged with other information in a study. Future work on co-design, model construction, and gameplay is needed in order to strengthen these methodological possibilities.

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