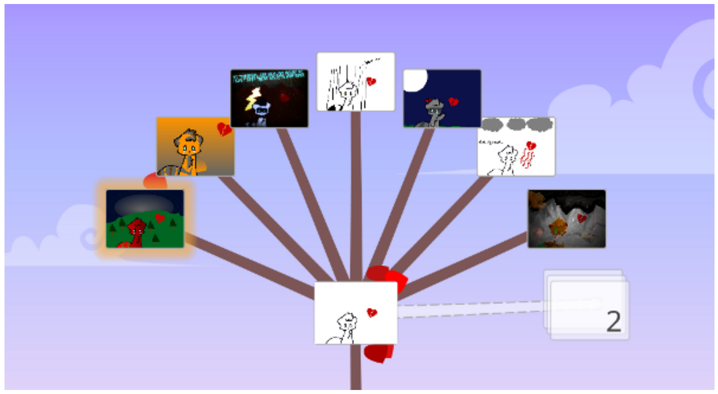

Birds of the Same Feather Scratch Together

Stefania Druga, Project Draft

"Youth are constantly looking at one another's projects, trading ideas, sharing techniques. To support this, the object architecture of Scratch supports what we call *deep shareability*" - Maloney et al., 2004 [24].

Abstract

In this project we aim to investigate what evidence of homophily and heterophily we can identify when observing children's activity on an Scratch online programming platform (largest platform for kids online with more than 21,295,050 unique visitors per month [1]. We specifically seek to understand how some algorithmic interventions, such as featuring remixed projects on the homepage, influence the diversity of children's interactions. We hypothesize a more diverse network could lead to an increase in platform retention and therefore to an improvement in children's programming practice.

Working definitions:

- *Homophily* refers to the degree to which pairs of individuals who interact are similar with respect to certain attributes, such as beliefs, values, education, social status, etc.
- *Heterophily* is the degree to which pairs of individuals who interact are different with respect to certain attributes [31].
- *Network diversity* in our project is defined as multidimensional heterophily measured across the following dimensions: gender, age, language of platform users.
- *Computational thinking* involves three key dimensions: (1) computational concepts (i.e. events, parallelism) (2) computational practices (i.e. iterating, remixing, abstracting), and (3) computational perspectives(i.e. expressing, questioning)[3].

[1]https://scratch.mit.edu/statistics/

1 Introduction

The effect of peers and feedback in online networks has been studied at length for adults [22, 8] however very few studies have tried to identify how these effects play out in children's' and youth networks [20]. Prior studies looking at network effects for youth took place primarily in schools or other in-person communities [26, 1, 5, 7]. Their findings showed both positive effects of homophily for youth, such as more effective communication, affiliation and identity building [12, 11] and negative effects like diminishing empathy, polarizing attitudes in evaluation of peers [16].

In order to better understand how these effects might play-out when children interact online we decided to study the evidence of homophily and heterophily in Scratch, the largest online platform for children, as study how these network effects might impact user retention and therefore computational thinking learning [4, 3, 17]. When looking specifically at computer science learning in other formal and informal learning settings we see evidence of homophily playing a significant role in learners retention for students who preferring to learn with peers of the same gender or race [19, 34, 29].

A study conducted in the earlier days of Scratch has found that the most senior Scratch users, those who have spent the longest time on Scratch and still frequent the site, are the most likely to program with advanced programming concepts with the greatest frequency of use. On the other end of the spectrum, users who have created new accounts are less likely to have this programming profile [10, 9].

In this context we think it would particularly be meaningful to understand how the projects that get featured on the front page could help increase children's exposure to a wider variety of projects and therefore create a sense of belonging for scratchers of all ages, race and gender. We started by looking at the featured remixed projects as this selection of projects is determined by an algorithm and therefore it's effects can be analyzed reliably over and extended period of time.

The remix functionality was initially introduced as a way to encourage Scratch collaboration and diversity of programs [25]however it's adoption in the community has lead to polarizing reactions with many users requesting for it to be removed [2]. Currently on the Front Page, there is a section called "What the Community is Remixing" and it shows the most remixed projects in the last ten days. Most commonly appearing in this section are drawing contests and remix chains.

In order to measure causal differences in remixing associated with being featured on front page we pose the following hypotheses:

- H1: Featuring projects on the front-page will increase peer-production of creative learning projects.
- H2: Featuring projects on the front-page will change the structure of the authors' social graphs and therefor lead to different forms of engagement.
- H3: Featuring diverse projects(diverse topics, diverse authors) on the front-page will increase peer-learning.

In order to test our hypotheses we choose to look at data from the entire month of remixes and analyze what type of projects got featured and how that event changed the social networks

[2]https://scratcharchive.asun.co/forums/viewtopic.php?id=26430p=1

of the their authors. We present our initial conceptual work around how homophility should be measure and analyzed in this context. In the next steps we plan to use the differences in differences method and specifically look at how the launch of a new website on May 9th 2013 which included a big update in the way remixed projects were featured impacted the Scratch social network homophily at scale. We plan to select random clusters from the network before and after this change and calculate their assortativity coefficient [28, 38]. These results will be correlated with changes in programming practices of the network actors and platform retention scores.

2 Background

Researchers in communication, learning sciences and social psychology have been underlying the importance of moving away from focusing on individuals as units of analysis, and focus on the importance of communication relationships. Relational analysis is a research approach in which the unit of analysis is a relationship between two or more individuals [31]. Concepts like homophily-heterophily are instrumental to guide the analysis of dyadic or other types of relational data and the data-analysis methods amount to using the dyad, network, or the subsystems as the unit of analysis. Social scientists who began systematic observations of group formation and network ties in the 1920s ([2, 35]) noted that children formed friendships and play together at higher rates in schools if they had similar demographic characteristics. The classic reference in social science seems to be Lazarsfeld Merton's study of friendship process [21]. Their use of the term "homophily" consolidated the observations of early network researchers and linked it to classic anthropological studies of homogamy (homophily in marriage formation).

Lazarsfeld and Merton distinguished two types of homophily: *status homophily*, in which similarity is based on informal, formal, or ascribed status, and *value homophily*, which is based on values, attitudes, and beliefs. Status homophily includes the major sociodemographic dimensions that stratify society—ascribed characteristics like race, ethnicity, sex, or age, and acquired characteristics like religion, education, occupation, or behavior patterns. Value homophily includes the wide variety of internal states presumed to shape our orientation toward future behavior. We begin with the former, then move to the latter because they often prove to be derivative of social positions themselves.

These two types of homophily can produce a division of a social network into densely-connected, homogeneous parts that are weakly connected to each other. For example, James Moody created a social network to describe the relationships between students from a town's middle school and high school (see fig 1). Two main divisions in his network are apparent: one based on race (with students of different races drawn as differently colored circles), and the other based on friendships in the middle and high schools.

The above example of the highschool racial homophily discovered by Moody is now a classical example which invites further reflection on how such a network would influence these youngsters personal and professional development. Discovering the evidence of homophily is only the first step to try to understand it's causal relationships and implications. Already Georg Simmel emphasized the way in which affinity networks develop across multiple dimensions of social life. Individuals occupy unique social positions through the combination of individual attributes and voluntary associations. And it is at the intersection of so-called "social circles" where identity is construed (p 135) [37]. Social Identity Theory [14] extensively deals with how

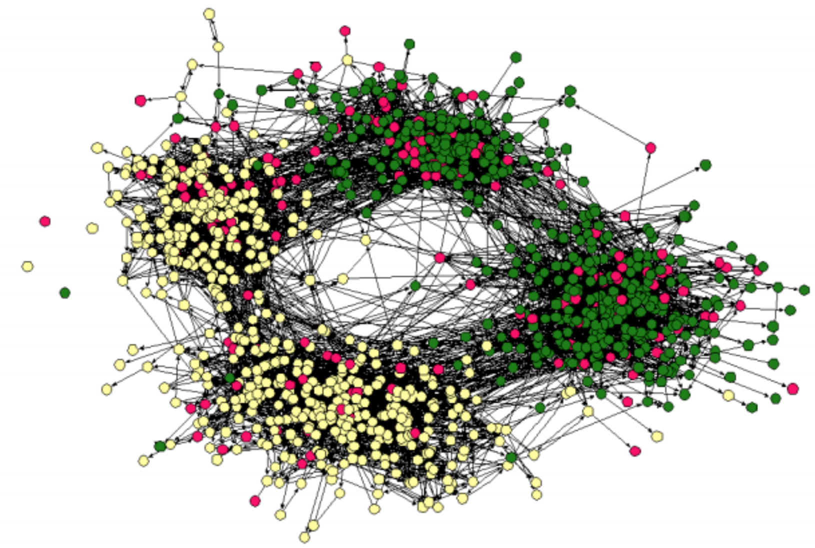

Figure 1: Example of social network within a particular middle school and high school (encompassing grades 7-12). Students of different races are drawn as differently-colored circles. Source: James Moody 2001 [26].

self-categorization into groups relates to engaging in activities that are perceived as stereotypical for a group-member. As a result, young adults take part in specific activities, because they meet other similar people through these activities. From the perspective of identity development, the mechanics of preference and opportunity are fused, as youngsters may prefer activities that create opportunities to meet similar others and make friends.

In our project we aim to investigate how this might relate to how middle-scholers create affiliation networks in Scratch and how that might influence and be influence by their identity development but also impact the degree to which they get introduced to different computational thinking practices and concepts [36].

2.1 Gender Homophily and Computer Science Education

> "Gender, then, involves active choices that are always in flux and that are determined by many things (race, class, age, peers, immediate context). Thus, the kinds of activities that have been described as "what girls really do" are not neutral or isolated acts, but involve the person becoming and acting in the world as part of the construction of a complex identity. In this case, we might argue that designing 'games for girls' misses the point." - Yasmin Kafai, 2017 [18].

One of the main dimensions we are interested in exploring in terms of homophily effects on programming skills learning is gender. In early studies of face-to-face interactions Shrum et al.[33] analyzed gender and racial homophily in a sample of friends from an American school (junior, middle and high school). Their findings indicate that racial homophily increases and gender homophily decreases with school grade. Rose and Rudolph's also found that girls seem

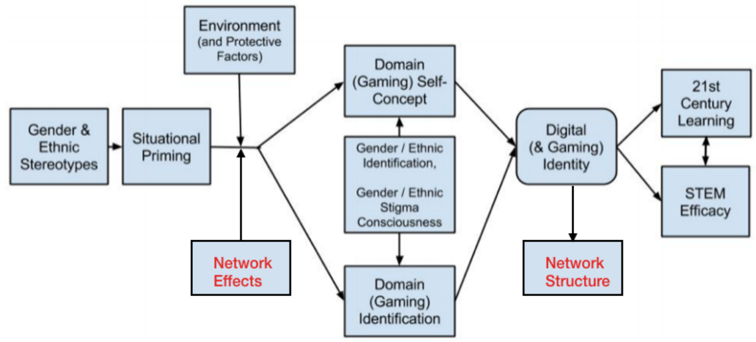

Figure 2: Model of players self-concepts and response to threat adapted from Richard 2013 [29] to include potential interventions of network effects and impact on network structure in our example in Scratch community

to have a greater preference for extended dyadic interactions and pro-social behavior, while boys interact more in peer groups with a high network density and clear dominance hierarchy[32] .

In a more recent study, Laniado et al. analyzed the interactions of 10 million users of Tuenti, a Spanish social networking service popular among teenagers. In dyadic relationships they also found evidence of higher gender homophily for women. This study also noted a preference of users with more friends to connect to the opposite gender. By examining the gender composition of triangle motifs, the researchers discovered a marked tendency of teens to group into gender homogeneous clusters, with a particularly high number of male-only triangles [20]. These findings were confirmed by another study that observed teens interaction on MySpace. Most interactions were with females and with persons of the same ethnicity, age, and state. In this study developmental differences are discussed as adolescents showed greater age homophily than emerging adults[23].

These trends in online interaction are important to understand as we know communication behaviors influence women's experience of the computer science learning, in and out of school [19]. Moreover there seams to be a correlation between students' perceived gender similarities with others in the CS discipline. Varna et al. showed in a longitudinal study with a group of diverse(gender & race) 66 students that gender homophily was the most significant retention predictor for youth engagement with computer science education [34]. Looking specifically at Scratch community, Kafai et al. showed in a series of prior studies that affinity networks on Scratch lack both gender and racial diversity and that girls overall tend to drop-out sooner and learn less on Scratch [17, 9]. This could also be explain by the fact that women and students of color are more significantly vulnerable to stereotype threat [29], which has a measurable negative relationship to gaming self-concept (or belief in their abilities) that, in turn, affects persistence (see figure2)[29, 30]. While it is difficult to know how many children have left Scratch due to lack of affiliation or other perceived threads, persistence seems to be an exercise in resiliency against the odds, as can similarly be seen in computing and STEM environments, where women and racial/ethnic minorities are often outnumbered.

While prior studies showed positive effects of remixing in order to promote diversity and collaboration through user initiated remix competitions [27], in our study we seek to understand when remixing and how remixing is leading to increased homophily in the scratch network to

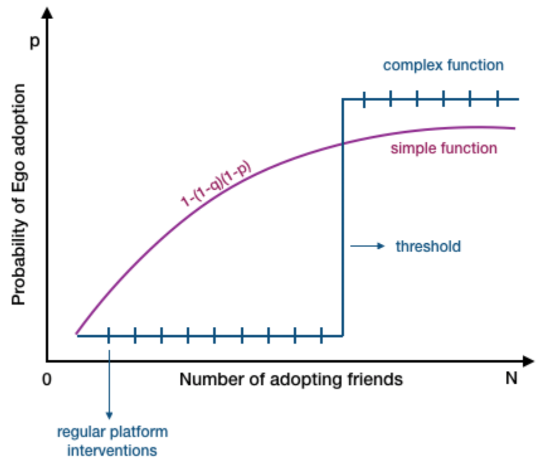

Figure 3: Conceptual model of peer influence in social networks based on a public lecture from Dean Eckles delivered in 2014 [4]

the extent that it allows minority groups to "hang-out" but it prevents them from "geeking-out" [18, 15].

3 Methods

For the context of this project our analysis focuses on Scratch [5], an online community and social networking forum focused on young people's computer programs. Since the site was launched in May 2007 from the MIT Media Lab, over 21.2 million registered members have collectively developed over 55 million projects using this platform.Scratch uses a visual programming language that allows for the creation of games, stories, and animations [24]. This platform has been designed primarily for 7- to 16-year old, however it has users of all ages.It's intuitive building-block approach to programming reduces the possibility of syntax errors while still affording computational thinking skills [3]. To encourage personalized project development, programmed objects can be any two-dimensional graphic image, either hand-drawn or downloaded from the Web. The platform also provides a rich collection of assets to be used in projects consisting of characters (sprites) and sounds.

Users contribute to site interactions by publishing their own projects, downloading and "remixing" friends' programs, adding "favorite" projects to their page, and commenting or selecting "love-it" on other users' projects. Descriptive statistics listed below each project show the number of times a project has been viewed, downloaded, "favorite"-ed, and remixed; as well as the locations of any user-created galleries that currently host the project (see fig 4). Popular projects have a chance to make it to the Scratch front page. Most Scratch users really wish to make it to the front page as their projects will receive more views, downloads, and feedback. While the primary function of the Scratch site is programming, project creation and social networking are deeply embedded through various forms of participation [17, 10].

For our analysis we used the following two main sources of data:

[5]http://scratch.mit.edu

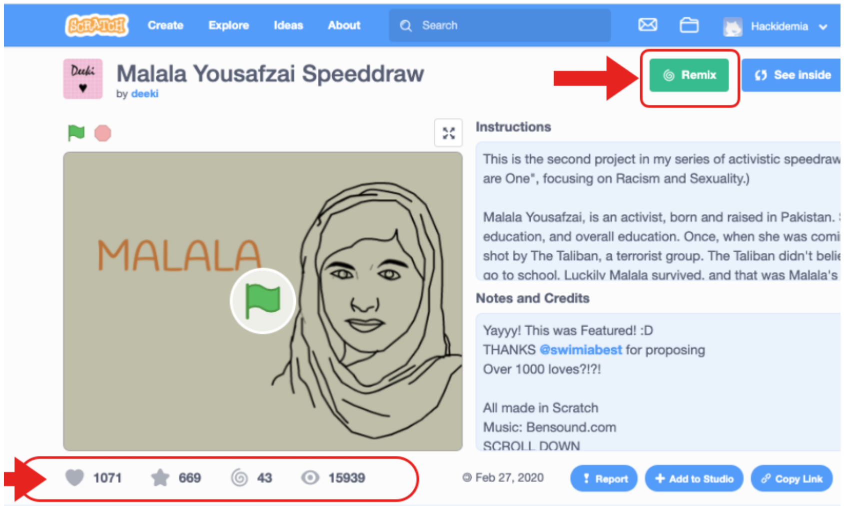

Figure 4: Example of a scratch project identifying the key platform interaction features: remix, like, favorite

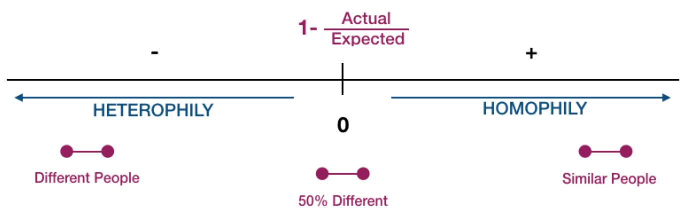

Figure 5: Conceptual Homophily Scale

- A public longitudinal data set of Scratch Projects created by Benjamin Mako Hill and Andres Monroy in collaboration with the Scratch Team at MIT. This includes the public activity in the Scratch online community during its first five years (2007-2012). The dataset comprises 32 tables with information on more than 1 million Scratch users, nearly 2 million Scratch projects, more than 10 million comments, more than 30 million visits to Scratch projects [6] [13].
- The collection of Scratch website captures from Internet Archive's Way Back Machine which saved 7,615 captures of this website between September 2, 2006 and March 20, 2020 [7].

4 Data Analysis

For testing our hypotheses 1 and 2 we are going to use the differences in differences statistical method. Difference in differences is a statistical technique used in econometrics and quantitative research in the social sciences that attempts to mimic an experimental research design using

[6]https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/KFT8EZ
[7]https://web.archive.org/web/20080715000000*/http://scratch.mit.edu/

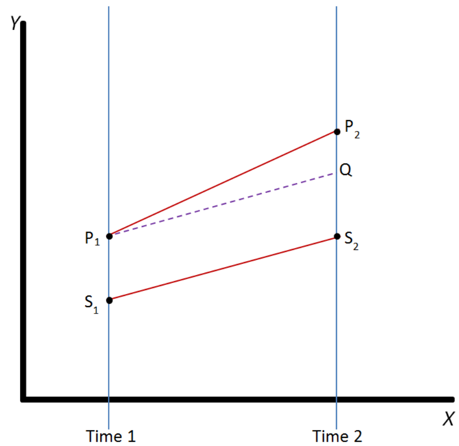

Figure 6: Differences in differences graph, Illustration by Danni Ruthvan, 2014

observational study data, by studying the differential effect of a treatment on a 'treatment group' versus a 'control group' in a natural experiment. In our case the treatment group is the group of projects that get featured in the front page in the remix banner and control group is the cluster of projects that are right under the threshold of number of remixes needed to be featured.

Using this method we plan to calculates the effect of the remix feature treatment on an outcome (i.e., number of followers, diversity of the group of followers) by comparing the average change over time in the outcome variable for the treatment group, compared to the average change over time for the control group. Currently we are still discussing and deciding what measure to include into our logistical regression formula in order to make this comparison.

For each group of analyzed projects we will generate a social graph using the Gephy open-source tool [8]. For testing the evidence of homophily in these graphs we will use the random link construction method and apply a homophily test to our new generated clusters [8]. Homophily Test: If the fraction of cross-gender edges is significantly less than 2pq, then there is evidence for homophily. In Figure 7, for example, 5 of the 18 edges in the graph are cross-gender. Since $p = 2/3$ and $q = 1/3$ in this example, we should be comparing the fraction of cross-gender edges to the quantity $2pq = 4/9 = 8/18$. In other words, with no homophily, one should expect to see 8 cross-gender edges rather than than 5, and so this example shows some evidence of homophily.

5 Initial Findings

By doing a simple search on Scratch we notice some evidence of gender homophily by looking at examples of boys and girls gallery of projects (studios).

[8]gephi.org

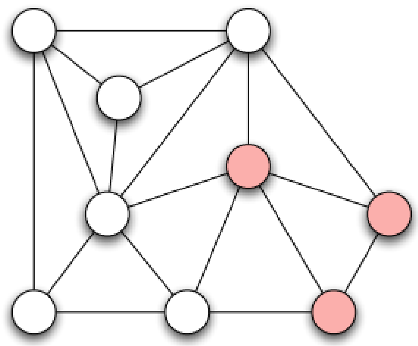

Figure 7: Using a numerical measure, one can determine whether small networks such as this one (with nodes divided into two types) exhibit homophily. Source: Easley and Kleinberg 2010, page 88 [6].

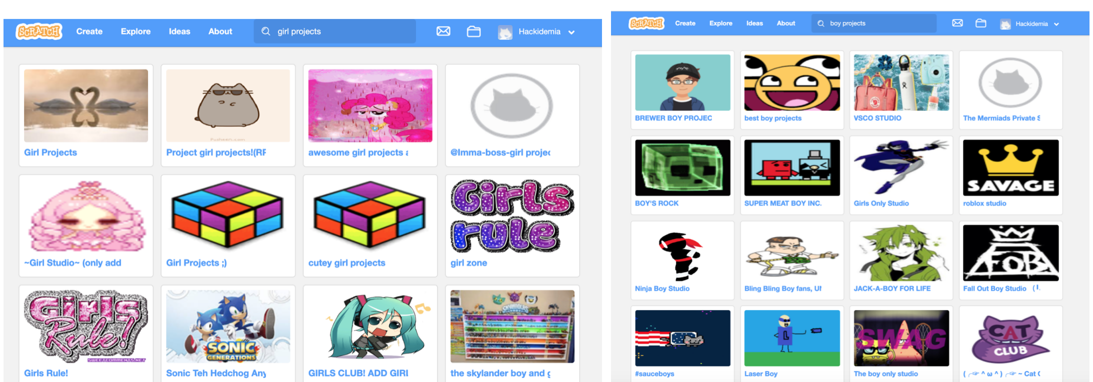

Figure 8: Examples of homophily in Scratch: girl projects and boy projects studios

5.1 Case study: July 2008

After consulting the Scratch wiki, which is run and updated by users, we learned that many Scratchers thought the feature remix section on the front page was not diverse enough to reflect the variety of remix projects on Scratch when it was initially launched. In response the Scratch Team encouraged Scratchers to find a ways to bring more diversity to the section and initiatives such as featured design studio were launched.

In order to understand better were the users complaints were stemming from we took an in-depth look at all the featured remixes from an entire month of July 2008 (see fig 9). We picked this month because it the Wayback Machine website had screenshots for it for almost every day (most screenshots compared to other months) and because it was a few months after the launch of the "top remix banner"and kids were doing the projects during the Summer break so we wouldn't get as many projects done in schools or more formal settings.

What we notice from looking at all the featured remixes from this month is that all the featured projects except one ("The Moving Test") were chain projects were users would only add new characters, like in the "Chain it pass" or "Make a Sprite link" projects, or just edit text on the backstage, like in the "The never ending story" project.

The "Moving test" what the only project where the goal was to modify the code by changing the rules or speed for a character to move around the maze. However all the remixes except one out of 14 were done by the project original authors as seen in figure 11.

Andres Monroy-Hernandez, who was the original architect of the first Scratch online community, mentioned the trade-offs a community might do when creating an infrastructure for remixes in his Ph.D. thesis in 2007.

> "(..)Remixing systems need to decide whether quantity (i.e., generativity) or quality (i.e., originality) of remixing is desired. This decision can change, but the levers needed to incentives one or the other are the same: author status, content complexity, and cumulative provenance. For example, when starting a community one might want to favor quantity over quality. Later on, system designers might want to promote more original remixing by highlighting works of medium complexity and by less popular contributors" - Andres Monroy-Hernandez 2007 [25].

From this month snapshot we can recognize in action the tensions between generativity and quality. After a deeper investigation we found that some of these users who were featured on the front page and still have active profiles on Scratch after 12 years (i.e brie700, cheezthecoolasdragon, ClubPenguinRocks, benjamin2 etc) have a majority of chain remix projects in their published gallery and many more followers (100-500) than people they are following (20-60). These Scratchers could be described more as "networkers" or highly socially engaged members of the community, rather than coders. In her prior study of 5000 users, Fields et.al notices a similar trend and brings forth the question of how the profile of community activity and the programming practices influence each other [9].

From this first anecdotal example it seams that the initial remix featuring algoritm was much more conducive to generativity rather than quality. With the launch of the new website in May 9th 2013 the Scratch team tried to address some of these concerns and changed not only the number of projects displayed in the featured remix banner but also the way the algorithm selected these projects (see example from fig 11).

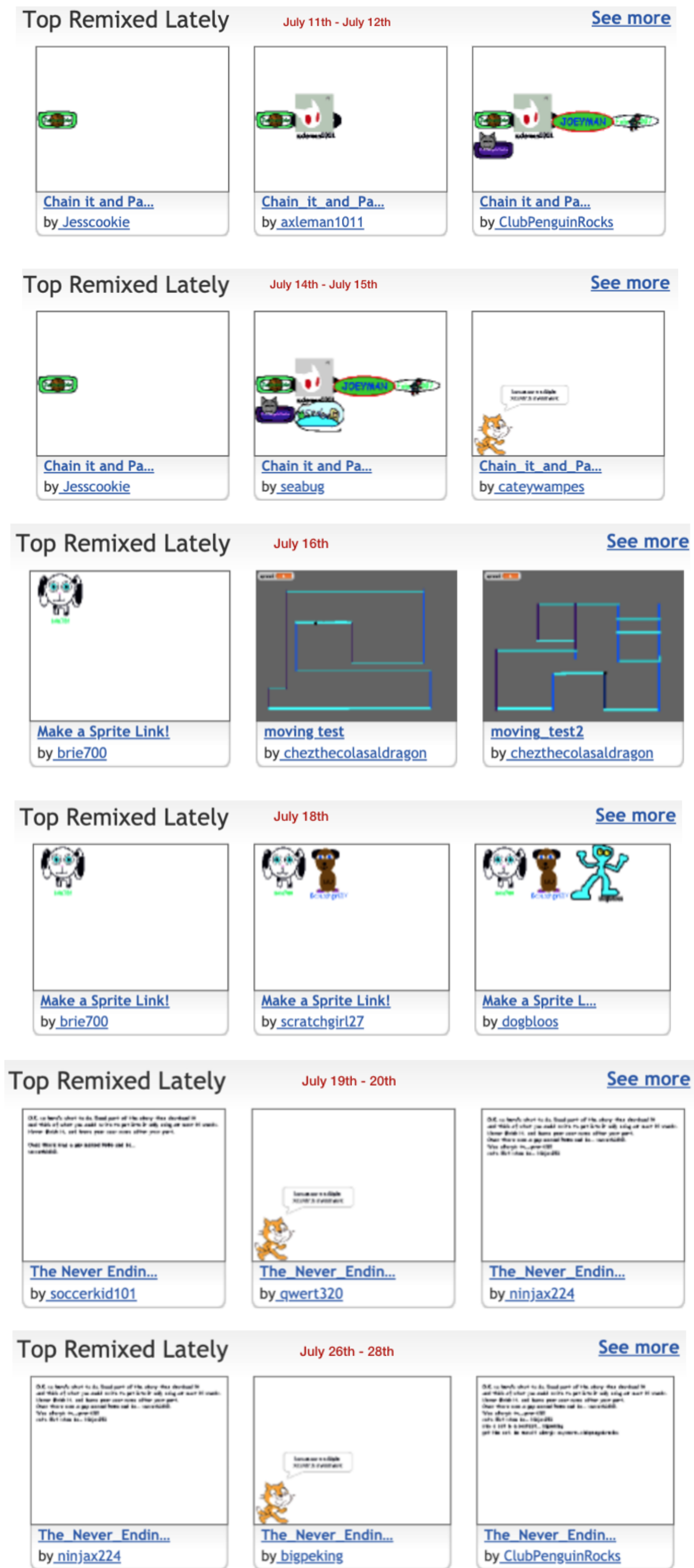

Figure 9: Timeline of featured remixes in July 2008, retrieved from Internet Archive Way Back Machine [10]

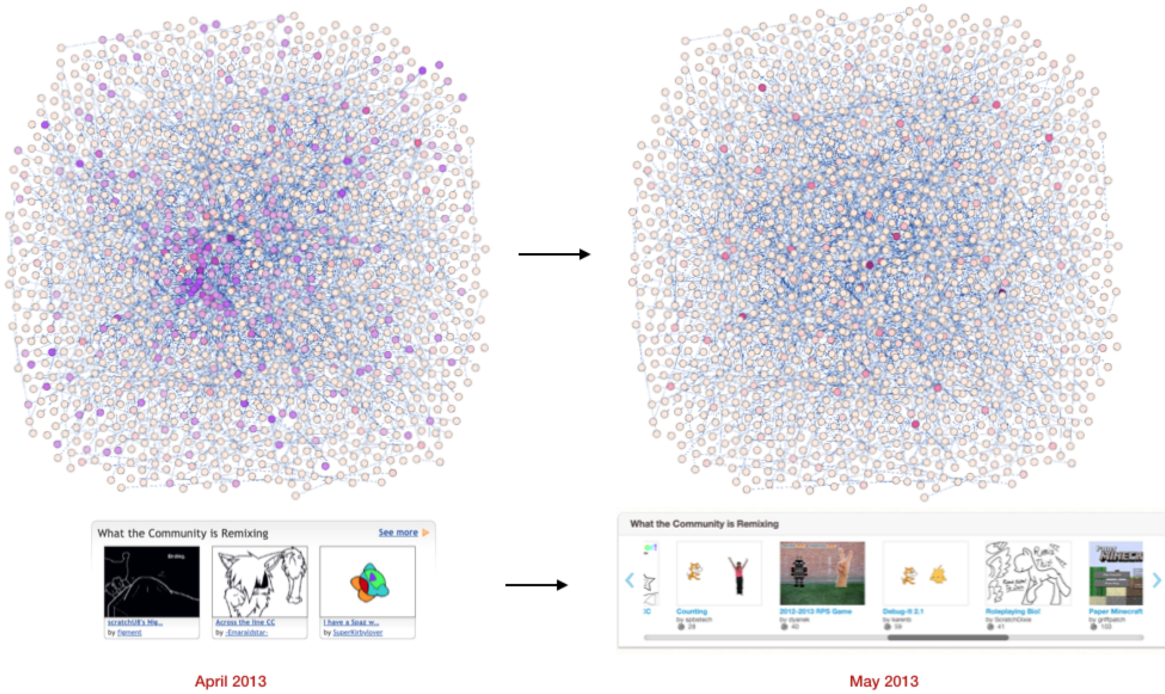

Figure 10: Expected results: increase in heterophily

6 Anticipated Results

Currently we constructed the non-directional graph on the left bellow which is composed of 1685 nodes and 1000 edges. The nodes represent users on the scratch platform that were featured on the "top remix" banner for the Month of April 2010. The edges represent their links to other users (following or followed by). We plan to construct a similar graph for the same number of users after the new remix banner was introduce in May 2010 and measure the differences in the network homophily. Our initial assumption is that we will observe a decrease in homophily as the new remix banner features a wider range of projects.

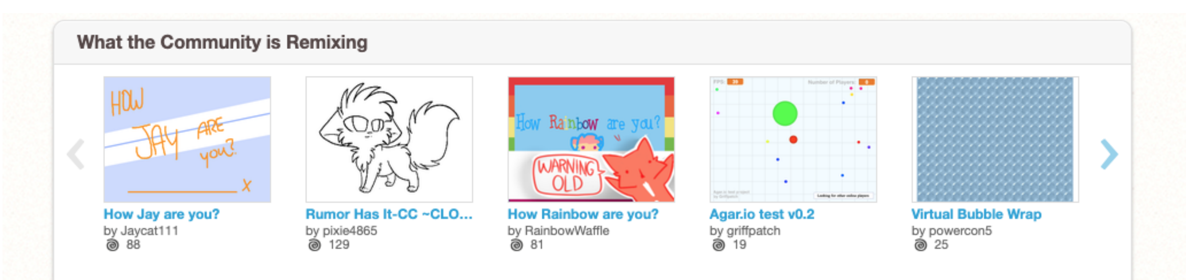

Figure 11: Latest Remix Feture Banner, retrieved from Scratch.mit.edu on March 16th 2020

7 Next Steps

Our future research will analyze the different types of motivations for remixing: relational and functional. Relational remixing serves as a way to connect with others, while functional remixing plays a purely pragmatic role, is a mechanism to "get the job done." We believe that understanding the primary mechanisms that lead children to remix a project will help us better understand the relationship between structure-agency effects on affiliation and therefore long-term learning.

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8 annex

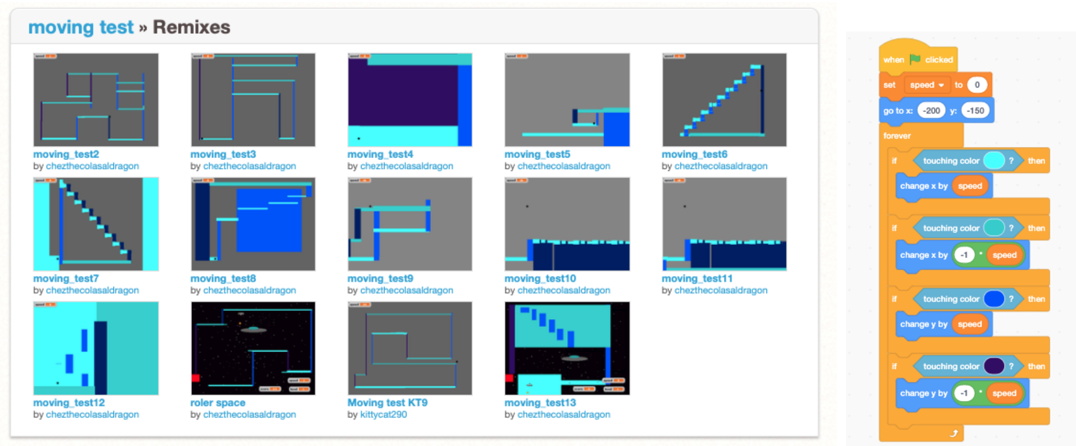

Figure 12: Example Remix project with coding: "Moving test"

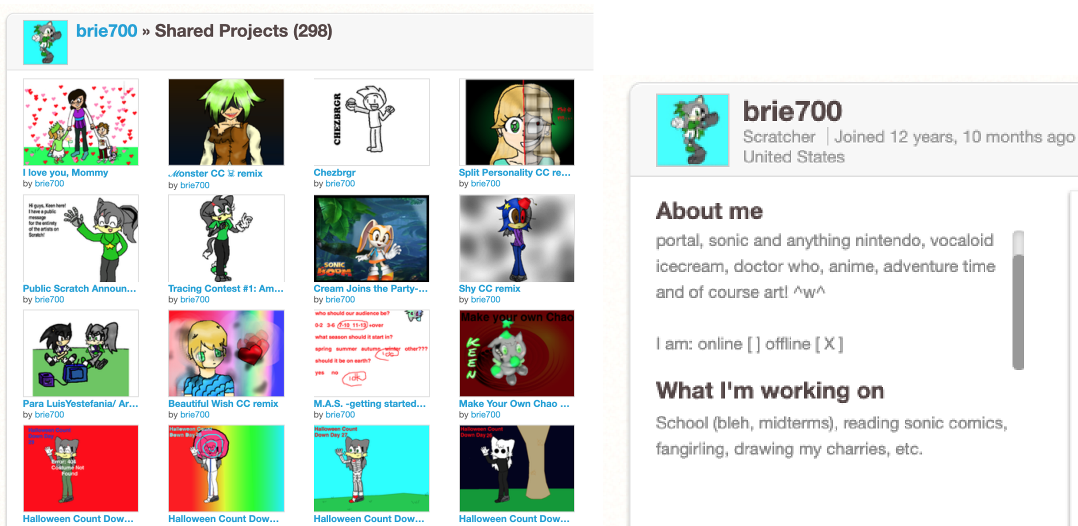

Figure 13: Example of projects and bio from a featured user

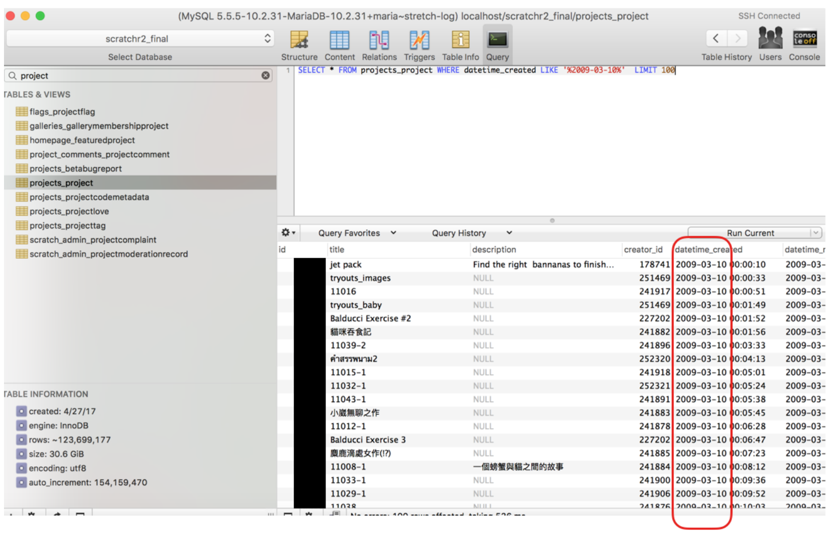

Figure 14: Example of data of top 100 remixed projects from 2009-03-10