# Successful Online Socialization: Lessons from the Wikipedia Education Program



ANG LI*, University of Pittsburgh, USA
ZHENG YAO*, Carnegie Mellon University, USA
DIYI YANG, Georgia Institute of Technology, USA
CHINMAY KULKARNI, Carnegie Mellon University, USA
ROSTA FARZAN, University of Pittsburgh, USA
ROBERT E. KRAUT, Carnegie Mellon University, USA

Attracting and retaining newcomers is critical and challenging for online production communities such as Wikipedia, both because volunteers need specialized training and are likely to leave before being integrated into the community. In response to these challenges, the Wikimedia Foundation started the Wiki Education Project (Wiki Ed), an online program in which college students edit Wikipedia articles as class assignments. The Wiki Ed program incorporates many components of institutional socialization, a process many conventional organizations successfully use to integrate new employees through formalized on-boarding practices. Research has not adequately investigated whether Wiki Ed and similar programs are effective ways to integrate volunteers in online communities, and, if so, the mechanisms involved. This paper evaluates the Wiki Ed program by comparing 16,819 student editors in 770 Wiki Ed classes with new editors who joined Wikipedia in the conventional way. The evaluation shows that the Wiki Ed students did more work, improved articles more, and were more committed to Wikipedia. For example, compared to new editors who joined Wikipedia in the conventional way they were twice as likely to still be editing Wikipedia a year after their Wiki Ed class was finished. Further, students in classrooms that encouraged joint activity, a key component of institutional socialization, produced better quality work than those in classrooms where students worked independently. These findings are consistent with an interpretation that the Wiki Ed program was successful because it incorporated elements of institutionalized socialization.

CCS Concepts: • **Human-centered computing → Human computer interaction (HCI)**.

Additional Key Words and Phrases: online production community; socialization; collective socialization

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*Both authors contributed equally to this research.

Authors' addresses: Ang Li, ANL125@pitt.edu, University of Pittsburgh, USA; Zheng Yao, zyao2@cs.cmu.edu, Carnegie Mellon University, USA; Diyi Yang, Georgia Institute of Technology, USA, diyi.yang@cc.gatech.edu; Chinmay Kulkarni, Carnegie Mellon University, USA, chinmayk@cs.cmu.edu; Rosta Farzan, University of Pittsburgh, USA, rfarzan@pitt.edu; Robert E. Kraut, Carnegie Mellon University, USA, robert.kraut@cmu.edu.


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## 1 INTRODUCTION

Attracting, retaining and integrating new participants is both essential and challenging for every organization[30]. Online production communities face this challenge especially acutely, because the cost of leaving is so low and the resultant turnover is so high [2, 14, 39]. Without a steady stream of newcomers to replace those who leave and to bring in new labor and new ideas, online peer production communities struggle with sustainability and production. For example, a 2009 study of Wikipedia found that 60% of new Wikipedia editors make no edits after their first day on the site [39]. Indeed, Wikipedia's Strategic Plan identified high turnover among newcomers as a major problem that the organization needs to address and made increasing participation one of its top priorities[1].

This high turnover is especially harmful because to operate effectively in an online production community, newcomers need to learn community-specific vocabulary, norms, roles, tools and skills. In open source software communities, for example, they need to understand how the software is organized, who are the important gatekeepers, and the norms around reporting bugs or making changes [15]. In Wikipedia, they need to understand important rules and norms about such topics as the type of content that is appropriate, writing with a neutral point of view, trustworthiness of sources, citations and formatting styles as well as getting familiar with some of the communication, editing and citation tools that Wikipedia provides. As Butler and colleagues noted back in 2008, Wikipedia had hundreds of pages documenting its complex structures of rules, processes, policies, and roles [9] and the structure has only gotten more complex since then.

Therefore, attracting and socializing newcomers is critical for sustaining online production communities. Despite this need, however, most online communities, including Wikipedia, provide little structure for socializing new members. Socialization refers to "the process by which an individual comes to appreciate the values, abilities, expected behaviors, and social knowledge essential for assuming an organizational role and for participating as an organizational member" [32]. In contrast to conventional work organizations, with their human-resources departments, handbooks, and training, most volunteers in online production communities are left to sink or swim on their own. As Narayan et al. [38] noted, "large peer production communities, including Wikipedia, have relied almost exclusively on individualized socialization techniques, [akin to on-the-job-training], and typically require users to figure out what they need to know in order to contribute to a project" (p.1786) In Wikipedia, most new editors learn what to do through trial and error, by requesting help and feedback, and by consulting help pages. They learn what not to do when they receive warnings, advisory messages, or reverts from more experienced editors. While both researchers and practitioners in the field acknowledge the importance of recruiting and socializing newcomers[11], there is currently little theory or empirical research to support the design of successful socialization processes in such communities.

In response to the decline of new editors in Wikipedia and the poverty of content that Wikipedia provides on some academic topics, the Wikimedia Foundation started the Wiki Education Project (Wiki Ed) in 2010, and the Wiki Education Foundation assumed responsibility for it in 2013. Wiki Ed is a program that encourages university instructors to include Wikipedia writing assignments in their courses. We focus on the Wiki Ed program because it is one of the largest interventions, involving over 63,000 students who worked on over 83,000 articles, adding the equivalent of 137,803 double-spaced pages of text [20]. In addition, unlike the standard practice in Wikipedia and the many existing interventions (e.g., [13, 19, 24, 35, 38]), which bring in newcomers one at a time with little formal and structured socialization [12], the Wiki Ed program provided its participants a structured, collective experience as newcomers. Wiki Ed includes features such as formalized

[1] https://meta.wikimedia.org/wiki/Strategy/Wikimedia_movement/2017

tutorial and training modules, clear timetables, constructive guidance, and cohort support, which are all elements of institutionalized socialization [27], a process that integrates newcomers through a formalized on-boarding program.

Although there have been multiple attempts to improve the integration of newcomers into Wikipedia, they have often been ad hoc, and only a few have been rigorously evaluated (see[35],[38] and [46] for exceptions). Morgan and Halfaker conducted a randomized experiment to evaluate the Wikipedia Teahouse, an friendly environment where newcomers could ask questions of more experienced Wikipedians. Although only a small fraction of newcomers invited to Teahouse actually visited it, the experiment showed that those who were invited were more likely to continue participating in Wikipedia compared to those not invited[36]. In contrast, Narayan et al. [38] conducted a randomized experiment, inviting newcomers to take part in the Wikipedia Adventure, an interactive tutorial that offered a structured and gamified introduction to Wikipedia. Only 22% of those invited completed any of the seven quests that comprised the tutorial. Although those who used the tutorial judged it engaging and well-designed, neither the invitation nor actually using the tutorial influenced the amount or quality of new editors' work. Vetter et al. [46] used qualitative methods to evaluate the effectiveness of the Wiki Ed project for the students who participated. However, little research has examined the impact of this intervention on newcomer retention or the quality of their work [18]. In addition to the lack of systematic evaluation, many of these interventions have little theoretical grounding to explain why they work. Therefore, even if empirical evaluation demonstrated the success of a particular intervention, without theoretical grounding, it will be hard to understand which components of the interventions were important and to generalize the success to alternative interventions in Wikipedia or in other online production environments.

The current paper evaluates the success of the Wiki Ed program. Results suggest that Wiki Ed produced both short-term and long-term benefits for Wikipedia. In the short term, student editors added substantial amounts of good quality content to Wikipedia. Compared to new editors who joined Wikipedia in the conventional way, Wiki Ed students contributed more content of higher quality. In the longer term, those who participated in the Wiki Ed program continued to contribute to Wikipedia after their classes were over compared to new editors who joined Wikipedia after the end of the Wiki Ed class but did not receive the Wiki Ed experience. Wiki Ed students in classes that encouraged group work produced higher quality articles than those who came from more individualistically-oriented classes. Moreover, the personal support provided by classmates through social interactions seemed to play an important role in the process. These results are consistent with an interpretation that the Wiki Ed program was successful because it was a structured socialization experience, which incorporated key elements of institutionalized socialization, including collective socialization and cohort support with a group of peers, segregation from most experienced community members, and clear time tables for performing tasks. Overall, this paper makes four key contributions:

- It evaluates the impact of the Wiki Ed program on both short term and long term outcomes, including the amount and quality of the work newcomers performed and the extent the program increased their commitment to the community compared to other methods of assimilating newcomers.
- Using both quantitative and qualitative methods within a longitudinal dataset, it analyzes students' social interactions with other students and the broader Wikipedia community to better understand the role of communication in the process of newcomers' assimilation into an online production community.

- It applies organizational behavior theories to examine how specific elements of institutionalized socialization, such as cohort support, might contribute to the success or failure of Wiki Ed.
- It suggests design implications of cost-effective socialization techniques that can be generalized to other online production communities.

## 2 RELATED WORK AND RESEARCH HYPOTHESES

### 2.1 Newcomer Socialization In Wikipedia and Wiki Ed

Wikipedia is history's largest encyclopedia, created and maintained by its users. As in many other online communities, new members join Wikipedia individually, and except for voluminous and potentially overwhelming documentation, they get little support. Although new editors can join Wikipedia and technically start editing on their first day, unlike new employees in most organizations, they do not go through a formal on-boarding process. Most receive a welcome message that points them to basic documentations, such as articles on the basic principles of Wikipedia, instructions on how to edit pages, and a simplified style manual. The welcome message also invites them to play the Wikipedia Adventure game [38] or to ask questions in the Teahouse. But they are not given assignments, explicit training, or mentors. Interactions with established editors are sporadic and frequently involve a rebuke or removal of their work. To sum up, although Wikipedia provides some resources, most socialization of newcomers at Wikipedia's happens informally and mainly through individualistic tactics.

To recruit editors who could contribute to social science articles and other academic topics not well represented in Wikipedia and to improve their socialization experience, the Wikimedia foundation formed the Wiki Education program (Wiki Ed) in 2010. Now run by the Wiki Education Foundation, the program encourages and supports instructors to incorporate Wikipedia-writing assignments in their classes. Since 2010, the Wiki Ed program has supported over 3,200 courses and with over 66,000 students who collectively added over 60 million words to Wikipedia.[2] As part of a course assignment, college students work individually or as a group to edit one or more Wikipedia articles.

The Wiki Ed program combines three strategies used in previous efforts to improve editor socialization and retention. It (1) identifies college students as potential candidates who would be a good "fit" to the community and its mission (a la, LeadWise[19]), (2) provides them with detailed guides and tutorials to help them adapt (a la [38]), and (3) connects them with experienced Wikipedia facilitators (a la [35]).

### 2.2 Institutionalized Socialization and Cohort Support

Socialization is the process by which newcomers make the transition from being organizational outsiders to being insiders [6]. Prior research on newcomer socialization in organizations distinguishes between individualized and institutionalized socialization tactics [30, 45]. Individualized socialization is similar to on-the-job training, in which newcomers join an organization one at a time and immediately start to perform their jobs, sometimes under the mentorship of a more experienced employee. In contrast, institutionalized socialization is a more formal on-boarding process, in which newcomers are brought into the organization in groups, are partially segregated from experienced organizational members, and put through structured training and mentoring activities [27]. Van Maanen and Schein [45] identified six major dimensions of these socialization tactics: (1) collective vs. individual socialization (i.e., socialized with a cohort of peers vs. individually); (2) formal vs. informal socialization (i.e., newcomers segregated from old-timers vs. socialized

[2]https://dashboard.wikiedu.org/

with them); (3) sequential vs. random socialization (i.e., socialized with or without a predefined sequence of experiences leading to a specific goal); (4) fixed vs. variable socialization (i.e., socialized with a clear timeline vs. socialized with a flexible schedule; (5) serial vs. disjunctive socialization (i.e., socialized with an experienced member to serve as a role model and mentor vs. socialized by oneself, without observing senior members; and (6) investiture vs. divestiture socialization (i.e., socialized by incorporating newcomers' prior identity and existing skills vs. socialized without regard to their prior identity and existing skills).

Jones' empirical research was the first that demonstrated that institutionalized socialization reduced newcomers' anxiety and uncertainty, and led to better job satisfaction, role clarity, self-efficacy, commitment to the organization and work quality[27]. These early findings demonstrating the superiority of institutionalized socialization tactics over individualized ones have been confirmed by meta-analyses comprising at least 70 distinct samples of newcomers, showing that newcomers who join companies using institutionalized socialization tactics perform better and stay longer [6, 43].

Although it was not explicitly based on theories of organizational socialization, the Wiki Ed program incorporates many institutionalized socialization tactics. First, it incorporates collective socialization. Students, who are generally newcomers to Wikipedia, join as a cohort with classmates from their own university. Along with fellow students who share similar experiences, they learn about Wikipedia and the writing process. They have opportunities within class sessions and in informal interactions with fellow students to discuss their goals and problems and to share tips. In addition, some instructors augment cohort support by forming small teams of students to work on the same article. Second, the program implements formalized socialization by socializing newcomers segregated from experienced members of Wikipedia. Third, it implements sequential socialization with assignments following a meaningful sequence of steps for improving a Wikipedia article. For example, students might evaluate the quality of an existing article, search for credible sources or make small edits before embarking on a major rewrite of the article. Also, most participating students are required to complete tutorials and training modules before they can edit Wikipedia. (e.g. tutorials on article editing [3] or how to cite sources [4]). Fourth, the program implements fixed socialization, where students are typically provided with a syllabus containing a clear timetable of what they should be learning and the tasks they should perform. Fifth, the program incorporates serial socialization, by assigning a staff member to each class, who welcomes students (see Figure 1) and serves as a facilitator who helps instructors and students when they have questions. Finally, by connecting Wikipedia editing to students' majors and existing experiences, the program implements investiture socialization.

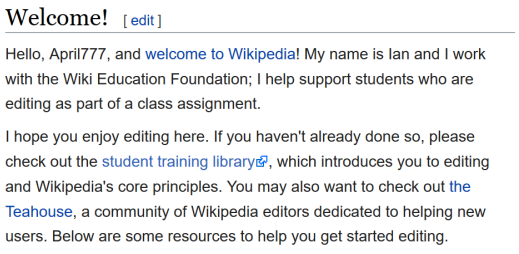


Fig. 1. Wiki Ed welcoming message

[3] https://en.wikipedia.org/wiki/File:Editing_Wikipedia_brochure_(Wiki_Education_Foundation).pdf
[4] https://en.wikipedia.org/wiki/File:Citing_your_sources.pdf

However, the effectiveness of institutionalized socialization depends on the structure of the organization, intra-group communication, and the ease of joining or leaving the organization[5]. These are dimensions along which Wikipedia differs from conventional offline organizations. The sporadic, lean communication in Wikipedia makes the development and maintenance of social relationships with other group members difficult to accomplish [28], weakening an important route to organizational commitment [41]. Moreover, joining and leaving Wikipedia is much easier than joining and leaving a conventional employment organization, which results in a lower level of continued commitment [2]. Thus, empirical research is essential to understand if and how the Wiki Ed program can be an effective practical solution for Wikipedia.

Given how successful institutionalized socialization is in offline organizations, the Wiki Ed program also has the potential to be successful online. We hypothesize that the Wiki Ed program and its use of institutionalized socialization tactics will improve the amount and quality of work newcomers perform and increase their commitment to the community compared to other methods of assimilating newcomers.

Thus, we hypothesize that:

**Hypothesis 1a:** *Wiki Ed, a socialization intervention, which includes some institutionalized socialization tactics, will be associated with more successful outcomes for online production communities in terms of newcomers' contribution and commitment.*

Collective socialization is an important component of institutionalized socialization. It refers to the process whereby newcomers are socialized in groups, typically with a common set of learning experiences[5]. Research in conventional organizations shows that collective socialization yields better socialization outcomes than bringing the newcomers in individually with on-the-job assimilation[43]. The common experiences that members of a cohort share help them develop camaraderie, learn from each other, develop a better understanding of organizational values[1].

In contrast to the institutionalized socialization often practiced in large companies, newcomers in online production communities generally join individually, with little direct interaction with other newcomers, even through other newcomers are facing similar experiences. Although collective socialization is successful offline, it remains an open question whether its use in online production communities will have similar effects. On the one hand, studies of online communities suggest that association with a group leads to higher commitment and a sense of belonging [16, 40] and that entering a community as a cohort may encourage higher levels of contribution from newcomers[18]. For example, in a study of newcomers editing Wikipedia articles, Farzan and Kraut[18] showed that cohort support resulted in a higher level of production and helped newcomers deal with the often negative feedback they received from established members of the community. Moreover, newcomers who reported stronger cohort support on a survey expressed a higher level of interest in continuing to contribute to Wikipedia. [44]

On the other hand, strong cohort attachment among newcomers may also create distance between them and existing members, and thus hinder their social integration into the community. Farzan and Han[17] found that strong connections among newcomers can create silos and discourage interaction with existing members of the community, even though interaction with old-times should be a primary channel through which newcomers gain "insider" information and learn the community norms. In an experiment with Mechanical Turk workers, Tausczik et al.[44] found that collective socialization led new editors to be more resistant to feedback from more established editors.

We therefore hypothesize that:

**Hypothesis 1b:** *Group assignments within Wiki Ed classes, which should elicit stronger cohort support, will influence the success of the Wiki Ed program, but the direction and the extent of the effect is uncertain a priori.*

### 2.3 Social Interaction

Newcomers' social interactions play an important role in the socialization process[6, 45]. Like new employees in corporations, new members of online communities face uncertainty about what is often an overwhelming and complex environment that is new to them. Through interactions with more senior organizational members and peers, newcomers seek information to reduce uncertainty [43]. Reduced uncertainty and familiarity with what is expected of them improve newcomers' job satisfaction, production, and retention in the organization [6].

However, the content of these interactions can moderate how they influence newcomers' subsequent behavior. Constructive feedback [31] and more inclusive language, have been associated with greater subsequent participation by newcomers [8, 31]. While criticism causes newcomers to fix problems pointed out to them them[54], it discourages longer-term participation [23].

Through interacting with fellow newcomers in their cohort, new members can learn from and provide support to each other as they go through a common set of challenges, which in turn can improve the quantity and quality of their work. Newcomers who are tightly connected and communicate with a small group of peers are more likely to become integrated into the larger organization [37]. Louis et al. suggested that frequent communication with peers is one of the most effective socialization practices leading to higher production [33]. Consequently, within the context of online production communities, we hypothesize that:

**Hypothesis 2a:** *More social interaction with peer newcomers within Wiki Ed will help improve newcomers' contribution and commitment to Wikipedia.*

On the other hand, communication with existing community members could have mixed effects. Existing research in multiple online communities showed that social interaction with experienced members, whether initiated by newcomers or experienced members, can help newcomers make sense of community norms and learn the ropes. Such interactions could help both in production and commitment (e.g., in Wikipedia [12], Usenet groups [4], and Facebook [7]). However, other research showed that even though existing members could provide mentorship and guidance to newcomers, they often do not do so. For example, they often categorize the newcomers as an out-group and treat them poorly [34]. In many online environments, newcomers are treated with suspicion until they have proven themselves[42]. Wikipedia, in particular, is known as a hostile environment for newcomers. As Morgan et al. note, "the new editor experience of Wikipedia can be an unsettling combination of anonymous and hostile". Old-timers frequently send newcomers critical messages and delete their work if it does not comply with Wikipedia's standards [23]; thus, interaction with old-timers frequently drives newcomers away [24, 25]. Thus the effects of interactions with established community members are likely to depend on the valence of the interactions, i.e., their positive or negative tone.

**Hypothesis 2b:** *Social interaction with existing members of Wikipedia may influence newcomers' contribution and commitment, but the direction of the influence depends on the valence of the interaction.*

## 3 METHODS

To evaluate the Wiki Ed program as an intervention that implements a number of institutionalized socialization tactics, we employed a mixed-methods approach. We first conducted statistical analyses of large-scale behavioral data to assess the relationships among participation in the Wiki Ed program, newcomers' social interactions, and their production and commitment. To provide more insights into the role of social interactions during socialization, we then complemented the quantitative data analyses with a qualitative content analysis of the interactions on Wiki Ed students' user talk pages from randomly sampled 40 students.

### 3.1 Quantitative Analysis Method

We used the roster[5] provided by Wiki Ed as the source to collect a list of 770 classes and 16,819 students participating in Wiki Ed during four semesters–Spring and Fall 2015, and Spring and Fall 2016. To focus on newcomers, we excluded 196 students who had edited Wikipedia prior to their class participation.

As we are not able to evaluate the Wiki Ed program through a controlled experiment, in which participants were randomly assigned to a Wiki Ed or non-Wiki Ed condition, the current study relies on observational data to make inferences about the impact of the Wiki Ed program. Several endeavors had been made to improve the validity of the current study.

First, our assumption is that most students who participated in Wiki Ed did so because they were interested in the topic of a course and not because it incorporated a Wikipedia writing assignment. Indeed, based on the Wiki Ed courses two of the current authors have taught, most students choose a course without knowing it will be part of the Wiki Ed program. People who participate in Wiki Ed classes may differ on many dimensions from those who register for Wikipedia through other mechanisms. For example, compared to Wiki Ed students, the Wikipedia editor population is more likely to be male, includes both younger and older individuals (e.g., approximately 50% are over 30), and has a greater diversity of educational attainment, with approximately 45% having elementary or high-school degrees and approximately 20% having advanced degrees [49]. Despite these differences, Wiki Ed students are less likely than other new editors to register for Wikipedia because they want to edit the encyclopedia.

Second, to evaluate the impact of Wiki Ed, we compared them to two control samples of Wikipedia editors who joined Wikipedia in the conventional way, without the benefit of the structured socialization that the Wiki Ed program provided or the extrinsic motivation of editing Wikipedia for class credit. (Figure 2). We compared Wiki Ed students to an *in-semester control group* to assess their relative performance **during** the semester in which students took their Wiki Ed course. Editors in the *in-semester control group* registered at the English Wikipedia around the same time (+/- 5 days) as a corresponding Wiki Ed student editor. We also compared Wiki Ed student to an *after-semester control group* who registered on the English Wikipedia around the same time (+/- 5 days) that a corresponding Wiki Ed student finished his/her course. We compare Wiki Ed students to the *after-semester control group* to control for the extrinsic motivation of students editing for a course grade and to assess their relative performance and commitment **after** the semester was over, when participation was no longer required by course requirements. This comparison is a conservative test of the long-term impact of the Wiki Ed program. When the relevant course is over, presumably both the Wiki Ed students and *after-semester control group* are primarily contributing because of their intrinsic motivations. Because motivation to contribute typically declines rapidly with a member's time in the community[23], this comparison contrasts students who have already been a member of Wikipedia for approximately four months with a "fresh" editor who newly joined. Both control samples were the same size as the Wiki Ed sample (16,819 editors). We dropped user accounts in the two control groups that were registered as bots, i.e., automated tools that perform tasks such as undoing vandalism, importing content or identifying copyright violations.

For all three samples, we used the Wikipedia public API [6], Wiki Ed public information[7], and the Wikipedia dump[8] to collect editing activities of the editors, from their registration date until

[5] https://dashboard.wikiedu.org/campaigns
[6] https://www.mediawiki.org/wiki/API:Main_page
[7] https://wikiedu.org/
[8] https://dumps.wikimedia.org/enwiki/20190120/

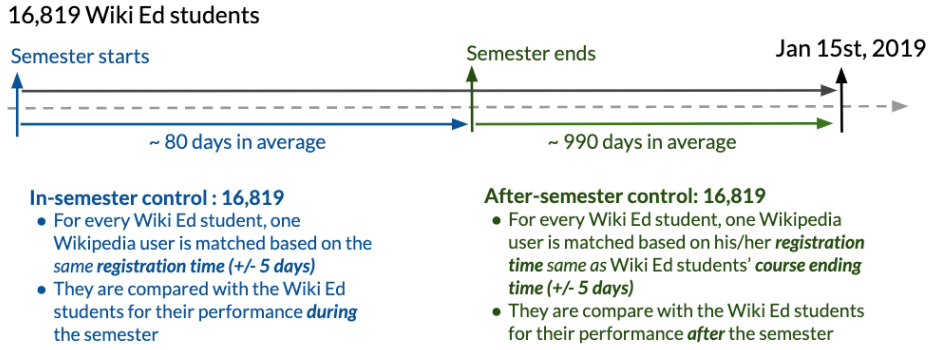


Fig. 2. Two control groups for Wiki Ed students

Jan 15, 2019 . Below, we first introduce the dependent, independent, and control variables in our quantitative analyses and then describe the statistical models that we used for each of the analyses.

*3.1.1 Dependent Variables.* We assessed the success of socialization in terms of newcomers' **production** in Wikipedia and their **commitment** to the Wikipedia community. We operationalized **production** in terms of ***effort*** and ***quality***. ***Effort*** is measured as *the number of edits* each editor made to Wikipedia articles[9]. ***Quality*** is measured as *the change in article quality* from the beginning until the end of the class in which students were enrolled. We compared *the change in quality* for articles edited by Wiki Ed students during the course period with the articles edited by the *in-semester control group* within the same time period. Unlike student editors, individuals in the control sample were not bound by a course schedule; to make analyses comparable, we defined a "pseudo-semester" for each editor in this control sample based on the course start and end date of their matched student editor. Therefore, the same time period is used for paired individuals in all our analyses. In total, Wiki Ed students edited 16,894 articles (7,530 articles edited as group assignments and 9,364 as individual assignments), while editors in the *in-semester control group* edited a total of 29,022 articles.

To assess ***quality*** for each edit revision, we adopted Wikipedia's ORES automatic quality assessment tool[10], which has been used in other work assessing the quality of Wikipedia articles [47, 48, 51]. The assessment tool is a machine learning model trained on human judgments of article quality. For each revision of an article, the model generates probability predictions that the article is at each of the six quality levels defined in the Wikipedia quality rubric[11]: Stub, Start, C, B, Good Article and Featured Article. In this quality rubric Featured Article (FA) is the highest quality class and Stub the lowest. Adopting the technique used by [22], we then converted these probability predictions into a single numerical score defined as the weighted average of a revision's quality levels multiplied by their probabilities. For example, imagine the model estimated the probabilities for all six quality classes of a version for the article *Communicative Planning* as $P(Stub) = 0.006, P(Start) = 0.031, P(C) = 0.393, P(B) = 0.182, P(GA) = 0.213, P(FA) = 0.172$. The

[9]The *number of edits* and *size of edits* are highly correlated, so we only used the number of edits in our analyses.
[10]https://www.mediawiki.org/wiki/ORES
[11]https://en.wikipedia.org/wiki/Template:Grading_scheme

weighted average combines them into a single numerical score: $1 \times 0.006 + 2 \times 0.031 + 3 \times 0.393 + 4 \times 0.182 + 5 \times 0.213 + 6 \times 0.172 = 4.072$.[12]

We examined ***effort*** during two time periods: (1) during the period when students were enrolled in a Wiki Ed course, presumably motivated by the course requirements and grade; and (2) after the course was over, when their participation was not required and was more likely to be intrinsically motivated. We set the break-point between in-class and out-of-class performance as ten-days after the official end-of-class date listed on the course website to minimize the possibility that students continued their editing to finish up assignments.

We measured ***commitment*** using *retention*, defined as the number of days after the end of the semester the individual editor continued editing Wikipedia. If their last edit was within 30 days of the end of our data collection period (Jan 15, 2019), we considered participation censored with an unknown end date. Our results are robust to censoring thresholds of 30 days vs. 60 days. For simplicity, we report our results using the 30-day threshold, a common industry practice (e.g., see [26, 29]).

We assessed the ***effort*** of Wiki Ed students during the course period by comparing them to editors in the *in-semester control group* (i.e., those who registered about when students registered). We assessed both the ***effort*** and ***commitment*** of Wiki Ed students after the semester finished by comparing them to the *after-semester control group* (i.e., those who registered about when students finished their courses.

*3.1.2 Independent Variables.* **Participation in Wiki Ed**: Compared to editors in the control groups, students in the Wiki Ed program received a socialization experience that incorporated to a degree all six elements of institutionalized socialization, including cohort support, training modules, and clear time tables. The control group editors, in contrast, typically joined Wikipedia by themselves without formal socialization programs. They experienced the individualized socialization typical of newcomers to most online communities.

**Group Assignments**: In some classes, students in the Wiki Ed program worked in a small group to improve an article while in others students worked individually on their Wikipedia assignment; we consider the team-based assignment a stronger implementation of cohort-based socialization. To distinguish group-based vs. individual-based Wiki Ed students, we assumed students were in groups and experienced stronger cohort support if more than one student from the same class worked on the same article during the semester (as per [18]]. In addition, we utilized information posted by instructors on their Wiki Ed course pages, which often indicated whether the class required group-based work. We then manually assessed this information for all 770 courses to confirm whether the class involved group-based or individual assignments.

In addition to working in groups, the strength of the cohort socialization experience also varied across other dimensions across classes. For example, students in classes where instructors reserved class time for students to discuss the processes of editing articles, Wikipedia community norms, and standards for quality had stronger cohort socialization than classes where instructors relied upon the Wiki Ed tutorials, which students completed outside of class. However, these variation were invisible to the researchers and not systematic; we expect these variations to be randomly distributed among all classes. Therefore, in this research we focus on team-based assignments as a factor leading to stronger cohort support that varies systematically across classes and can be reliably measured.

In summary, we identified three types of socialization, which we treat as a categorical variable in our analyses:

[12]his approach assumes that the quality scale is an interval one, with, for example, the difference between a Stub and Start article being the same as the difference between a GA and FA one.

- Wiki Ed students with group assignments: students in classes that included group-based Wikipedia assignments. We consider them to experience the highest level of cohort socialization, with support from both group mates and classmates.
- Wiki Ed students with individual assignments: students in classes that included only individual Wikipedia assignments. We consider them to experience a weaker level of cohort socialization, with support only from their classmates.
- Individually-joined editors: editors in the two control groups who joined Wikipedia independently and were matched to students in the Wiki Ed program based on their registration dates. We consider them to experience little cohort socialization, as they joined by themselves.

Our analyses are based on two orthogonal, one-degree of freedom contrasts. The first analysis contrasted Wiki Ed students with matched editors in the two control conditions. The second analysis differentiated among Wiki Ed students, to contrast those in group-assignment classes (strong cohort socialization) with those in individual-assignment classes (weak cohort socialization).

**Social Interaction**: We measured social interaction in terms of the number of posts on students' user talk pages. User talk pages are Wikipedia pages designed for communication and linked to a user's account, where editors can leave each other messages. [13] When users receive a message on their talk page and are logged in to Wikipedia, they see a notification on the top of each page they visit indicating "You have new messages", with a link to their user talk page. Editors who provided an email address when they first registered also receive an email notification that they have received messages. We distinguished these messages based on their source (other Wiki Ed students vs. non-student Wikipedians) and direction (whether they sent or received the message), defining four types of messages:

- Messages from Students: # of edits the focal student received from other Wiki Ed students on their user talk page
- Messages to Students: # of edits the focal student placed on other Wiki Ed students' user talk pages
- Messages from Wikipedians: # of edits the focal student received from editors who were not Wiki Ed students
- Messages to Wikipedians: # of edits the focal student placed on user talk pages of editors who were not Wiki Ed students

*3.1.3 Control Variables.* Factors such as the number of students in a class or editors' overall editing activity at different times can influence editors' production and commitment. For example, students in smaller classes might receive more instruction and attention about their Wikipedia assignments, which could lead to higher quality and quantity of participation in editing the Wikipedia articles. Students who edited heavily during a class might continue to edit heavily after the class was over. To account for such factors, we include the following control variables in our statistical models:

- Class Size: The total number of students in the same class as a focal student. Because editors in the control groups had no classmates, for analyses involving non-Wiki Ed editors we included the interaction term of class size and Participation in Wiki Ed. Participation in Wiki Ed is a dummy variable, where 1 means that the focal editor is a Wiki Ed student or 0 otherwise. This interaction term has the effect of controlling for class size only for Wiki Ed students.
- Number of edits on article talk pages: The total number of edits a focal student made on any Wikipedia article talk pages during the class period.

[13] https://en.wikipedia.org/wiki/Help:Talk_pages

- Number of edits on user talk pages: The total number of edits a focal student made on any Wikipedia user talk pages during the class period.
- Number of edits on user pages: The total number of edits a focal student made on any Wikipedia user page during the class period.
- Number of unique articles: The total number of unique articles a focal student edited during the class period.
- Edit size: The average size of content added by a focal student during the class period. The content size was standardized, with a mean of 0 and a standard deviation of 1.

Because some control variables represent highly skewed counts, they were subjected to a log transform before analysis. Class size served as a control in all analyses. The other control variables were incorporated in the survival models to account for the influence of newcomers' performance during a course on their subsequent retention.

*3.1.4 Statistical Models.* We used three types of statistical models to assess the effect of Wiki Ed on student editors' production and commitment:

(1) To assess Wiki Ed's effect on students' production during and after the semester, we conducted three regression analyses with each measure of production: *change in article quality during the semester*, *total effort during the semester*, *total effort after the semester* as the dependent variables. *Total effort*, the count of article edits, was log transformed to account for its skewed distribution, and was modeled using linear regression. The regressions to model effort were conducted with the editor as the unit of analysis. *Change in article quality* was modeled with the article as the unit of analysis to investigate whether the quality of articles edited by Wiki Ed students improved more than the quality of articles edited by those in the control groups[14].
(2) We used survival analysis to examine how variations in socialization experiences predicted the length of time from the end of a class to editors' stopping editing in Wikipedia. The results of the Cox regression are shown in terms of the hazard ratio (HR), the instantaneous likelihood of an event (i.e., leaving Wikipedia) happening. If HR is larger than one, the predictor is associated with an increased risk of dropout (i.e., a decrease in retention); if HR is smaller than one, the predictor is associated with decreased risk of dropout (i.e., an increase in retention).

All analyses were conducted as hierarchical models, with editors nested within a class as a random effect, to account for the non-independence of observations among students participating in the same class. Figure 2 shows a timeline for the analyses.

### 3.2 Qualitative Analysis Method

To better understand newcomers' interaction with others and how their communication might have influenced their integration with the Wikipedia community, we randomly selected 40 students (10 per semester) who had at least 5 edits on their user talk pages and examined the content of the messages they had exchanged with other students and non-student Wikipedians (331 messages in total). One coder manually coded their interactions using the coding schema developed by Choi et al.[12], which identified 7 socialization tactics: invitations to join projects, welcome messages, requests to work on a particular task, offers of assistance, positive feedback, constructive criticism, and personal comments. In addition, we added another communication type–personal awards. In contrast to feedback messages, which usually included comments on how to improve an article, personal awards are given by classmates as a gift to recognize a fellow student's effort on an

[14]We exclude articles that were edited by both groups

assignment. We distinguished the sources of the interaction in terms of whether it was from other students or non-Wiki Ed editors.

## 4 RESULTS

### 4.1 H1: The Wiki Ed program improved effort, quality and commitment

*4.1.1 During the Wiki Ed Program.* We first examined how effort and quality of users' contribution varied across the three levels of socialization: Wiki Ed students with group assignments, Wiki Ed students with individual assignments, and editors who joined individually. Table 1 reports the results. Compared with editors in the in-semester control group, being part of the Wiki Ed program was associated with higher production, regardless of group assignment. On average, Wiki Ed students made 14.12 times[15] more edits than did their matched in-semester control group editors ($\beta = 2.647, p < 0.0001$). In addition, entering Wikipedia through the Wiki Ed program was associated with larger improvements in the quality of articles editors worked on ($\beta = 0.207, p < 0.0001$). Specifically, the estimated mean ($\mu$) quality improvement score for articles edited by the *in-semester* control group was only 0.05 (i.e. the estimated mean article quality score improved from 3.33 at the beginning of the semester to 3.38 at the end of the semester), whereas articles edited by Wiki Ed students by 0.25, or five times as much (i.e. the estimated mean article quality score improved from 3.20 at the beginning of the semester to 3.45 at the end of the semester or mid-way between a C and B on the Wikipedia quality scale). In terms of the degree of cohort support, articles edited by student groups improved significantly more in terms of quality than those with individual writing assignments ($\beta = 0.050, p < 0.0001$). The estimated mean ($\mu$) quality score improvement of articles edited by Wiki Ed student who worked in groups was 0.29 (i.e., the estimated mean article quality score improved from 3.19 at the beginning of the semester to 3.48 at the end of the semester), whereas this number was 0.24 for articles edited by students who work individually (i.e., the estimated mean article quality score improved from 3.20 at the beginning of the semester to 3.44 at the end of the semester). The quality score improvement of articles edited by students who work as a group is 0.05 higher than the estimated mean quality score improvement of articles edited by students who work individually, a small but reliable increase.

These results suggest that the Wiki Ed program had benefits to Wikipedia, with the student editors doing more work and improving articles more than editors who came to Wikipedia through the standard route. However, the benefits of working in groups within the Wiki Ed program were smaller.

*4.1.2 After the Socialization Program.* It can be argued that Wiki Ed students worked harder and improved Wikipedia more than editors in the in-semester control group in part because of extrinsic motivations to contribute: they were working for a class grade. To more fully evaluate Wiki Ed's effect as a socialization program and not just as a short-term change in incentives, we examined Wiki Ed students' performance and commitment after the extrinsic incentives were removed. To do so, we compared Wiki Ed students' performance and commitment after their course was over with the performance and commitment of the *after-semester control group*, who registered after the end of the course.

In terms of the quantity of work after the semester was over, Wiki Ed students made 3.022 times more edits than did their matched after-semester control editors ($\beta = 1.106, exp(1.106) = 3.022, p < 0.0001$) ( see Table 1).

Moreover, participation in the Wiki Ed program was associated with greater retention in the community. Those who edited Wikipedia as part of the Wiki Ed program, either individually or in

[15]Since the dependent variable was log transformed, coefficients should be exponentiated before they are interpreted: exp(2.647)=14.12

| | During the program | | | | After the Program | |
|---|---|---|---|---|---|---|
| | Content Edits | | Change in article quality | | Content Edits | |
| | $\beta$ | P | $\beta$ | P | $\beta$ | P |
| Class Size × WikiEd | -0.136 | 0.001 | 0.003 | 0.785 | -0.26 | <0.0001 |
| Wiki Ed (vs In-semester Control) | 2.647 | <0.0001 | 0.207 | <0.0001 | | |
| Wiki Ed (vs After-semester Control) | | | | | 1.106 | <0.0001 |
| Wiki Ed with group assignments (vs individual assignments) | 0.049 | 0.137 | 0.050 | <0.0001 | 0.042 | 0.132 |

Table 1. Results of three separate regression analyses with each measure of production as a dependant variable [details in 3.1.4]: Participation in Wiki Ed is associated with more edits both during the program and after students' participation in the program ended. Group assignment improved article quality during the semester, but had no significant effect on the number of edits or the commitment after the program ended.

| | Survival Analysis | |
|---|---|---|
| | HR | P |
| Class Size × WikiEd | 1.157 | <0.0001 |
| Wiki Ed (vs After-semester control group) | 0.488 | <0.0001 |
| Group assignments (vs Individual assignments) | 0.970 | 0.266 |

Table 2. Wiki Ed is associated with significantly greater retention in the community.

a group, were 51.2% more likely to continue editing after the end of the course than editors in the matched control group (HR = 0.488, $p < 0.0001$). Table 2 summarizes these results, and Figure 3 presents the log-transformed survival curves for the three groups. Only 2.1% of the control group editors were still editing a year after the date the course had ended compared with 4.2% of the Wiki Ed students. However, there were no significant differences in either number of edits made or retention between Wiki Ed students who worked in groups (strong cohort support) and those who worked individually (weak cohort support)

In summary, these comparisons of the behavior of Wiki Ed students with in-semester and after-semester control groups demonstrate that the Wiki Ed program was associated with improved effort, quality, and retention of newcomers. The comparison of Wiki Ed students with editors from the after-semester control group is especially revealing. Since most editors' intrinsic motivation to contribute to Wikipedia is highest when they first join and declines over time [39, 53], one might have expected that editors from the after-semester control group, who were new to Wikipedia, would outperform the Wiki Ed students, who had already been editing for several months. However, the empirical results are the opposite of these expectations.

Although the Wiki Ed program was consistently associated with positive outcomes, the associations with the strength of cohort support (i.e., group vs. individual assignments within classes) were weaker. Being in a group-oriented classroom only improved work quality during the semester, but was not associated with improvements in the amount of work students did either during or after the semester nor their retention after the semester.

*4.1.3 A robustness check.* It is possible that some editors in the control groups registered for Wikipedia without ever intending to edit articles. Moreover, accounts can be created by administrators or created automatically when a user who is registered in a different edition of Wikipedia visits the English edition while signed in. Indeed 78% of editors in the control groups never make any article edits after registering. To test whether this difference in initial motivation was responsible

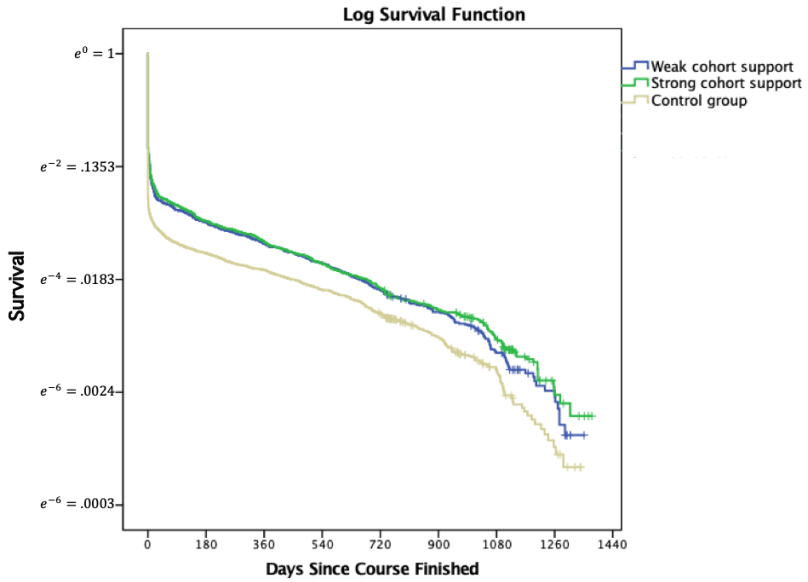


Fig. 3. Wiki Ed Students exhibit a higher rate of continued participation than the random sample, but group assignment has no effect with retention.

for the results just presented previously, we replicated all these analyses, including only Wiki Ed students and control group editors who made at least one article edit.

To do so, we selected the editors from both *in-semester* and *after-semester* control groups who edited at least once and compared them to their matched Wiki Ed students. Twenty-two percent of editors in each control group made at least one edit. To have a fair comparison, we also filtered out any Wiki Ed students with no edits. These rules led to a data set of 4,212 pairs of Wiki Ed students and their *in-semester* control editors and another of 973 pairs of Wiki Ed students and their *after-semester* controls. Using the method described in the paper section 3.1, we compared the performance of both control groups with their paired Wiki Ed students in terms of the contribution quality, effort, and commitment.

| | During the program | | | |
|---|---|---|---|---|
| | Content Edits | | Change in article quality | |
| | $\beta$ | P | $\beta$ | P |
| Class size × WikiEd | -0.314 | 0.001 | 0.001 | 0.431 |
| Wiki Ed (vs In-semester Controls who have at least 1 edit) | 1.678 | <0.0001 | 0.215 | <0.001 |

Table 3. Robustness Check: By comparison Wiki Ed students with *in-semester* control users who have at least one edit, the results keep the same: the participation in Wiki Ed is associated with more edits during the program.

Tables 3 and 4 demonstrate the results respectively for performance during the Wiki Ed course and after it was over. With respect to the *in-semester* comparison, results are consistent with those presented in section 4.1.1. That is, among editors with at least one edit, being in the Wiki Ed program was still associated with more content edits ($\beta = 1.678, p < 0.0001$) and larger improvements in

| | After the Program | | | |
|---|---|---|---|---|
| | Content Edits | | Survival – HR | |
| | $\beta$ | P | HR | P |
| Class size × WikiEd | -0.289 | 0.092 | 1.027 | 0.547 |
| Wiki Ed (vs after-semester Controls who have at least 1 edit) | 1.617 | 0.002 | 0.655 | 0.006 |

Table 4. Robustness Check: By comparison Wiki Ed students with *after-semester* control users who have at least one edit, the results keep the same: the participation in Wiki Ed is associated with more edits and commitment after the program.

article quality ($\beta = 0.215, p < 0.0001$) during semester. Wiki Ed students made 5.35 times more edits than did their matched in-semester control group editors.[16]. In addition, the improvements in quality of articles edited by Wiki Ed students was 0.215 points higher than of articles edited by in-semester control group.

With respect to the*after-semester* comparison among editors who edited at least once, the results are qualitatively the same as discussed in section 4.1.2. That is, Wiki Ed students edited significantly more compared to after-semester control group ($\beta = 1.617, p = 0.002$). In addition, those who edited Wikipedia as part of Wiki Ed, either individually or in a group, were 34.5% more likely to continue editing after the end of the course than the matched *after-semester* control group (HR = 0.655, p < 0.0001).

Overall, these results are qualitatively the same as those from analyses using all Wiki Ed students and control editors. Even among editors who made at least one edit, those who experienced the Wiki Ed program edited more, improved articles more, and participated in Wikipedia longer than those who joined Wikipedia in the conventional way without the structured socialization experience.

### 4.2 H2: The importance of social interaction

We then focused on Wiki Ed students and investigated how their social interactions influenced their contribution to and integration into the Wikipedia community. Specifically, we evaluated the association between the number, target, and direction of students' social interactions with their effort, quality of contribution, and commitment. The results for effort and quality are summarized in Table 5. The Total Content Edits regression model shows that all four types of social interaction were associated with greater effort by students. For example, a 100% increase in messages that Wiki Ed editors received from fellow students was associated with a 9.6% increase in edits; a 100% increase messages sent out to fellow students, on the other hand, was associated with 18.5% increase in edits. Although one could argue that the outbound communication (*Msgs to ...*) was itself an indicator of the effort student were devoting to Wikipedia, this argument only applies to inbound communication to the extent that students received messages primarily as a response to their outbound messages (*Msgs from ...*). However, since that outbound communication was included in the model when examining the effects of inbound communication, the results suggest that inbound communication has an independent effect on effort. In contrast to effort, receiving messages from other students was the only variable associated with a significant improvement in the article quality ($\beta = 0.013, p < 0.0001$)[17].

We also conducted survival analysis to examine how social interaction during the course predicted how long students' continuing editing Wikipedia after the course ended. The results are summarized

[16]Since the variables are log transformed, one unit of increase should be interpreted as exponential value of the unit: exp(1.678)=5.35

[17]Because the unit of analysis for evaluating article quality improvements is the article, social interaction here was also aggregated at the article level.

| | Regression Analysis | | | |
|---|---|---|---|---|
| | Total Content Edits | | Final article quality | |
| | $\beta$ | P | $\beta$ | P |
| Class size | -0.086 | 0.223 | ns | |
| Wiki Ed with group assignment | -0.063 | 0.101 | 0.020 | <0.0001 |
| Msgs from students | 0.096 | <0.0001 | 0.013 | <0.0001 |
| Msgs to Students | 0.185 | <0.0001 | ns | |
| Msgs from Wikipedians | 0.258 | <0.0001 | ns | |
| Msgs to Wikipedians | 0.204 | <0.0001 | ns | |

Table 5. All types of social interaction are associated with greater effort; only communication within students improves the quality of their articles.

in Table 6. Model 1 includes only the control variables and Model 2 adds cohort support (i.e., from group assignments) and the social interaction variables. The results from Model 1 indicate that smaller classes and initiating more communication during the semester were associated with longer retention in Wikipedia. Moreover, the more edits students made on article pages (HR=0.922, $p < 0.0001$), user pages (HR=0.903, $p < 0.0001$) and user talk pages (HR = 0.940, $p < 0.0001$), the more unique articles they contributed to (HR = 0.926, $p = 0.0012$), and the larger size of their edits (HR = 0.958, $p < 0.0001$) during the class the longer they continued editing on Wikipedia after the class was over. In contrast, students had less commitment in larger classes, with 2.71 ( exp(1)=2.71) additional students associated with 11.3% lower likelihood of continuing to edit Wikipedia after the class (HR=1.113, $p = 0.006$).

Model 2 demonstrates that social interaction during the course had significant associations with students' retention. Specifically, communicating with other students was associated with higher survival rates. Sending approximately three[18] additional messages to other students was associated with a 8% higher survival rate (HR=0.919, $p<0.0001$) and receiving approximately three additional messages from other students was associated with a 2.2% higher survival rate (HR=0.978, $p< 0.05$). However, interactions with Wikipedians who were not part of the Wiki Ed program had a mixed effect. Reaching out to Wikipedians was associated with a 10% higher survival rate (HR=0.896, $p<0.0001$) but receiving messages from them had no association on students' retention.

These results support Hypothesis 2a and 2b: more social interactions with students had positive associations with both students' contribution and retention. However, interaction with established Wikipedians had mixed results: though sending more messages to them predicted greater production and retention, but receiving more messages from them had no significant effect on either article quality or students' retention.

*4.2.1 The content of interaction varies with communication partner.* The qualitative analysis revealed two major forms of interaction among newcomers that might have affected their editing behavior: group coordination and peer feedback. We observed that students utilized Wikipedia talk pages to coordinate with each other on completing their assignments. Such messages typically included to-do lists or brief outlines of the article. Students also provided each other feedback and peer-reviews on their talk pages, which in many cases were explicit parts of the requirement of the class assignment. Students generally wrote positive and constructive messages to their peers, such as :

[18]Since the count variables were log transformed, a one unit increase in the log scale is equal to of increase should be interpreted as exponential value of the unit; therefore 1 unit additional edit is equal to exp(1)=2.7 increase in the original scale

| | Cox Survival Analysis | | | |
|---|---|---|---|---|
| | Survival Model1 | | Survival Model2 | |
| | HR | P | HR | P |
| No. edits in article page | 0.922 | <0.0001 | 0.924 | <0.0001 |
| No. edits in article talk page | 1.004 | 0.87 | 1.012 | 0.326 |
| No. edits in user talk page | 0.940 | <0.0001 | 0.990 | 0.436 |
| No. edits in user page | 0.903 | <0.0001 | 0.905 | <0.0001 |
| No. unique articles | 0.926 | 0.0012 | 0.923 | 0.0012 |
| Edit size | 0.958 | <0.0001 | 0.958 | 0.0001 |
| Class size | 1.113 | 0.006 | 1.094 | <0.05 |
| Wiki Ed with group assignment | | | 1.029 | 0.510 |
| Msgs from students | | | 0.978 | <0.05 |
| Msgs to Students | | | 0.919 | <0.0001 |
| Msgs from Wikipedians | | | 1.001 | 0.945 |
| Msgs to Wikipedians | | | 0.896 | <0.0001 |

Table 6. More interaction with other students is associated with higher survival rates; interactions with non-student Wikipedians have a mixed effect.

*"...Overall, I would say this article is extremely well done, and I am looking forward to reading the final draft..."*

In addition, students sought and received feedback from students in previous classes, who are more experienced in editing Wikipedia.

*...I was hoping to reach out to you as you have more expertise and experience writing medical articles on Wikipedia on ways to improve the content of this proposed page...When you get the chance, I was wondering if you could check out the current form of the page that I created...*

Moreover, students' interactions with their peers exhibited cohort support, often in the form of seeking information, sharing similar learning experiences, or providing social support by greeting or rewarding each other. For example:

*...I am trying to figure out how to use this Wikipedia thing...*
*...I'm learning how to communicate on Wikipedia...*
*Hello XX, nice to meet you and I am happy to share my XX class with you and all of our classmates. Let us all hope for the best to happen in this semester. I wish you a Good luck...*
*...A barnstar for you!*

The qualitative analyses showed a more mixed tone when students interacted with established Wikipedians. Students often reached out to Wikipedians, especially to Wiki Ed staff, for help. In response to such messages, Wiki Ed staff seemed to be very responsive to students' requests, usually responding to them within a day. Their responses usually included clear instructions along with guidance on norms and rules of Wikipedia. The tone of their messages to students was also generally positive and constructive. Examples of such messages includes:

*Problems like these tend to become greater as articles grow and other people add information. It would be helpful if ...*
*Nice work on your draft article, I notice that you haven't linked to other Wikipedia articles. Wikilinks are valuable to readers, since they allow them (readers) to learn more about the topics discussed in an article...*

*...Can you find a source that deals with the topic and use it to add to that section?*
*...here are a couple things to think about (to improve the article)...*

In contrast, feedback provided by established Wikipedians who were not staff was usually much less supportive and informative. As illustrated by the following quotes, established Wikipedians often indicated they disagreed with changes students made without giving much guidance about how to fix problems or edit more effectively. These observations suggest reasons for the results of quantitative data analyses that, although receiving messages from Wikipedians was generally positively associated with students' total effort, it did not improve editing quality or students' long term retention rate.

*...Deleted the image as a copyright concern...*
*Your sentence is weakly worded. Its not just a "fair bit" it creates a burden.*
*...You must therefore cite the best available evidence as well as write in a consistent format...*

## 5 DISCUSSION

In summary, results indicate that Wiki Ed was a successful intervention for improving Wikipedia. As shown in Table 7, compared to editors who joined Wikipedia individually, those who joined as part of Wiki Ed edited more and improved articles more while the program was underway. In addition, the Wiki Ed program seemed to have long-term effects. The Wiki Ed students edited more and participated in Wikipedia longer after the program was over than did editors who joined Wikipedia in the conventional way at the end of the program. These results are consistent if the analyses are conducted on all 16,819 Wiki Ed students and their matched controls or are restricted to just editors who made at least one edit. Overall, during the four semesters examined in the current research, students in Wiki Ed added around 27 million words, more than is contained in 22 copies of Tolstoy's *War and Peace*, and contributed to more than 24,000 articles related to academic subjects. These articles improved on average .25 points on the Wikipedia quality scale, while articles edited by the within-semester control group only improved .05 points. These improvements are at least partially caused by the extrinsic motivations associated with of course assignments, where students tried to improve their article to receive a good grade while editors in the control group did not. However, editors in the control group presumably had their own motivations, including such extrinsically oriented motivations as reputation, reciprocity, or the desire for self-development, as well as intrinsically-oriented motivations, including altruism and a sense of belonging to the community. Our results strongly suggest benefits from structured recruitment and socialization of newcomers into online production communities [50, 52]. In addition, Wiki Ed students edited more and participated longer in Wikipedia after the program was over than did editors who joined Wikipedia in the conventional way, suggesting that the Wiki Ed experience had long-lasting effects even when the extrinsic motivation of participating for a grade was removed.

The authors' experience using the Wiki Ed program in several of their own courses illustrates how the elements of institutionalized socialization incorporated into the program benefited the students and Wikipedia. The timeline provided by the Wiki Ed syllabus, laying out a sequence of increasingly difficult tasks, eased students into the Wikipedia environment. By trying out tasks in a sandbox, they were able to get generally supportive feedback from course instructors and fellow students before they posted their work publicly and risked negative feedback from more experienced Wikipedians. When negative feedback did come, they had instructors and fellow students to provide moral support and practical advice about how to handle harsh criticism. For example, when one student's new article was threatened with deletion, she got useful advice about how to respond in the public Article for Deletion debate and how to use authoritative sources to respond to criticisms. When an established Wikipedian deleted a substantial portion of one

| | At End of the Course | Long Term: After the Course |
|---|---|---|
| ***Analysis – Production*** | | |
| Wiki Ed (v.s. individualized) | –> (+) Effort, Quality | –> (+) Effort |
| Strong (v.s. weak cohort support) | –> (+) Quality | |
| Msg from Students | –> (+) Effort, Quality | |
| Msg from Wikipedians | –> (+) Effort | |
| Msg to Students | –> (+) Effort | |
| Msg to Wikipedians | –> (+) Effort | |
| ***Analysis – Commitment*** | | |
| Wiki Ed (v.s. individualized) | | –> (+) Commitment |
| Msg to Students or Wikipedians | | –> (+) Commitment |
| Msg from Students | | –> (+) Commitment |

Table 7. Summary of Quantitative Analysis

student's update to an article, another student in the class responded with the morale-boosting comment, "Yes, some more citations would help, but this article has come a long way in a short time. Keep up the good work!" Similarly, students' groups supported each other in dealing with feedback from the Wikipedia community. In one case, when Wikipedians suggested that students integrate a new article into an existing one, the student team constructed an argument together to defend their position on creating the new article.

Below, we discuss two specific findings. The quality of articles edited by students working as a group improved more than the quality of articles edited by students editing individually. This result suggests that cohort-support, one element of institutionalized socialization, is valuable. However, these two work styles did not differ significantly in terms of the total number of edits and retention. One possible explanation is working in a group helped students more effectively plan their revision, review a larger literature and critique each others' work, leading to quality improvements. However, the Wiki Ed students may have received more cohort support from their class as a whole than from the two or three others on their editing team. For example, other students in the class provide role models by showing their progress in the course, give tips about formatting and citations, among other topics, discuss how to deal with challenges in working with the community.

Our work also informs theory on the role of social interactions in the process of newcomers assimilation into an online production community, by examining how communication among members was associated with socialization effectiveness. The results suggested that communication among cohort members (and especially incoming messages from other classmates) is associated with an improved article quality. However, receiving messages from established Wikipedia members did not seem to improve article quality. This finding is inconsistent with prior literature on organizational socialization, which shows that contact with established organization members is generally helpful in reducing newcomers' uncertainty about their job functions, providing them appraisal information about how well they are performing and making them feel a part of the organization [1, 6]. This finding may be specific to the current context. Both prior research [23] and content analysis in the current study suggest that in Wikipedia, established members are suspicious of and even hostile towards newcomers. In this environment which is unwelcoming of newcomers [35], newcomers' communication with each other may serve as a buffer against hostile communication with established community members.

## 6 LIMITATIONS

This research has several limitations. First, the retrospective, correlational methodology used in this research cannot determine causation. The research did not experimentally manipulate whether students participated in Wiki Ed nor the degree of institutionalized socialization they experienced, but rather relied on natural variation among class instructors. Due to lack of sufficient data about the users, we were also unable to use pseudo-experimental methods such as propensity-score matching [21] or similar statistical techniques to control for pre-existing differences or to construct instrumental variables to account for possible opting-in to the Wiki Ed program [3, 38]. We showed that the behavior of Wiki Ed students differed from newcomers who joined Wikipedia in the conventional way, but cannot definitively show that participation in Wiki Ed per se, institutionalized socialization or communication with classmates and others was responsible for these differences. For example, pre-existing differences in age, gender, education and other characteristics between the students who participated in the Wiki Ed program and editors who join individually could account for some of the findings. The general Wikipedia population is more male (87%), older (73% over 21), and has a greater variation in education (approximately a third with secondary school education and a third with an advanced degree) than the undergraduates taking part in the Wiki Ed program [49].

Additionally, there can be auto-created accounts among our control group population. A common case of such accounts could be users who registered in another Wikipedia language and were thus automatically registered in English Wikipedia when they visited the English Wikipedia. This can inflate the number of registered users in our control group with those who might not have any motivation to register their accounts.

Second, this research focused on socialization processes in Wiki Ed where newcomers have an existing and obvious shared identity (i.e., students in a common university and class), limiting the applicability of this research when prior connections between newcomers do not exist [10]. However, even in communities where newcomers lack a common shared identity, they are often attracted because of connections with existing community members and word of mouth [30].

Furthermore, when examining social interaction, we only examined publicly visible online communication on Wikipedia talk pages, and undoubtedly underestimated the amount of communication between between students in the same classroom.

Finally, the study only examined production and retention outcomes, but not newcomers' subjective experiences in the community or the amount they learned from participating. While self-report methodologies such as surveys and interviews can be used to evaluate individuals' subjective experiences with institutionalized socialization, and thus able to reveal more nuance of how the socialization experience had worked, behavioral outcome is useful as one measurement of the success of socialization. Adding self-report outcomes to a study of socialization in Wikipedia will require researchers to overcome the substantial barriers of high non-response rates and sampling bias associated with survey studies. In our own work, when we attempted to contact new Wikipedia editors to engage with us, only 3 among the 250 editors we contacted responded. In Vetter et al's research only approximately 9% of the 6,000 students who participated in the 2016 version of the Wiki Ed program completed a post-course survey assessing its value.

Despite these limitations, our study provides an empirical understanding of Wiki Ed as an intervention in Wikipedia, one that seemed to have a positive impact on participants' effort, commitment and quality of work. To assist others in conducting follow-up research, we are releasing our entire annotated dataset and analysis scripts through an open-source repository[19]. Although the focus in this research was an evaluation of the Wiki Ed program per se, to the extent that

[19] https://github.com/LittleRabbitHole/WikiEd

components of the program that implemented institutionalized socialization mechanisms are responsible for its effects, the conclusions should generalize broadly to many types of online groups and communities, including health support communities, open source development projects and even online, multi-player games. For example, many online communities would benefit from social designs that provide newcomers a space to talk amongst themselves somewhat segregated from the oldtimers and give them clear guidelines about how to behave.

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