Learning by Playing Init2Winit: How Alignment Knowledge Increases Educational Aspirations and College Plans in High School

I-Chien Chen [a*], Christel Rocha-Beverly [a], Barbara Schneider [a]

[a] *College of Education, Michigan State University, East Lansing, USA*

I-Chien Chen

ichiench@msu.edu

ORCID #s:

I-Chien Chen #0000-0002-0223-552X

Christel Rocha-Beverly #0000-0002-2575-5130

Barbara Schneider # 0000-0002-3233-166x.

Init2Winit, a gamified mobile application designed to increase students' alignment knowledge between college, career, and salary expectations has been beta-tested in midwestern urban and rural U.S. high schools (age 14-18). Students earn different points in the game when their educational expectations and expected annual income are matched with their desired careers. Propensity score matching was used with 481 high school students to compare the changes in 4-year college plans, college-going aspirations, and educational expectations between players and non-players. Results show that Init2Winit players significantly increased their 4-year college plans and educational aspirations from fall 2018 to spring 2019 compared to those students who did not play the game.

Keywords: alignment, educational aspirations, career plans, mobile app

1. Introduction

Students from low-income communities experience shortages in family and school resources, resulting in lower educational achievement and college matriculation than peers from middle- and upper-income families (Bailey & Dynarski, 2012). Low-income, minority, and high school students (age 14-18) whose parents did not attend college may also have limited access to information about college preparation, the application process, college costs, and availability of potential financial aid options (Bettinger et al., 2012). When students' lack of resources is compounded with a scarcity of critical knowledge about potential college and career pathways, they often show a misalignment of their college and career ambitions choosing plans for college that are inconsistent with their future desired occupations (Perry et al., 2016).

Misaligned knowledge can be the result of overestimating or underestimating requirements for a student's chosen college or career pathway. High school students who are under-aligned assume the pathway to certain jobs can be achieved without completing a postsecondary degree. Under-alignment is more prevalent among young people in families and schools with limited economic and social resources. The consequences of misaligned knowledge for low-income students can be costly, leading to financial debt or drop out before obtaining a college degree.

The development of a new tool to transform students' learning experiences in college and career alignment knowledge can be facilitated with smartphone applications (Chen, Rocha-Beverly, Schneider, 2020). Init2Winit is a mobile app developed by the College Ambition Program research team. The app contains a suite of dynamic games designed to help adolescents learn about the relationship between college degrees, career requisites, and resulting salaries. Ultimately, Init2Winit aims to improve students' college and career alignment knowledge by combining a personalized

exploration of self and career goals with an incentivized mobile game. Init2Winit's point system motivates students to build knowledge and skills related to education and career pathways in- and out-of-formal schooling. Previous work demonstrated that multiple plays of the Init2Winit mobile application led to significant increases in students' alignment knowledge between educational aspirations and aligned career plans (Chen, Rocha-Beverly, Schneider, 2020).

The present study aims to evaluate the effects of the short-term intervention on 4-year college plans, college expectations, and gains in educational aspirations between Init2Winit players and non-players. We further examine whether students' improvements in educational aspirations and 4-year college plans could be attributed to their level of alignment knowledge between education requirements and career choices. Finally, we test whether there is a relationship between number of plays and users' improvements in educational aspirations and 4-year college plans.

2. Background

2.1 Program setting

Init2Winit employs a dynamic game design in the context of job exploration where students can envision and place themselves in a diverse range of careers, learn about the educational requirements for that job, and their estimated annual career incomes. Init2Winit is based on models of career planning which suggest that the primary, and most important, stage in developing a strategy for identifying an expected occupation is to visualize oneself in a job, see Figure 1. Init2Winit encourages the players to move to the second stage by transforming their interests into action. For example, the players align their selection of specific majors and estimated salaries of individuals with specialized expertise. The aim of the game is for players to create in the end, a strategic, aligned plan—an education pathway for a specific interest and/or career option.

[Insert Figure 1 here]

It is important to note, however, that this model is not envisioned as entirely predictive; students are apt to change their interests—the difference here is students' gameplay using Init2Winit can potentially assist them in learning more about the relationships between career options, corresponding college choices and perceived income benefits. Students who play Init2Winit can visualize themselves in career/college pathways with the choices they make in the game and can learn through trial/error in gameplay about the benefits of choosing certain education pathways, career choices, and earnings. Init2Winit game logic assumes that the stronger the alignment between education ambitions and career pathways, the more points students earn. This provides the students with a self-directed learning experience, feedback, and a chance to play the game again if they are interested in learning about the educational requirements for different careers.

This study uses a within-subjects design with fall and spring survey to determine whether high school students could learn alignment knowledge in the short-term intervention (e.g., playing Init2Winit), which in turn, increase their college plans and educational aspirations (Salkind, 2010). To account for the individual difference in the development of students' college-going attitudes, we controlled for the prior 4-year college plans and educational aspirations in fall semester. Cook, Shadish and Wong (2008) suggest that estimates from observation studies can approximate estimates from randomized experiments by including a control for a precondition of the outcome variable. Furthermore, controlling for the prior attitudes reduces the prediction errors and the impacts of unmeasured characteristics of individual students (Steiner et al. 2010).

Figure 2 shows study procedure of intervention as students were asked to complete a pre-test survey in the fall semester of 2018 (September to November). In the fall survey, we collected information on students' demographic characteristics, parent education, GPA, college plans, and educational aspirations. A follow-up survey was collected in June 2019 after launching Init2Winit (May 3rd to 29th). In the follow-up survey, we also asked students' career plans, 4-year college plans, and educational aspirations in the spring semester. The response rate of the fall survey was 81%, and the response rate of spring survey was 82%.

[Insert Figure 2]

2.2 Literature review

2.2.1 Theoretical perspective: Misalignment theory

This dynamic of unaligned educational expectations and occupational goals has been identified in the literature as misalignment, which has been shown to lower the rate of college enrollment and retention, especially for economically and socially disadvantaged students (Perry et al., 2016). Recent longitudinal research finds that high performing high school students tend to be over-aligned, aspiring to multiple advanced degrees for careers requiring only a bachelor's degree (Schneider, Kim, & Klager, 2017). Students with over-aligned college knowledge have educational expectations that supersede what is necessary for their career choice, or they over-estimated possible annual salaries in their career choices.

Misaligned knowledge, particularly under-alignment, can also adversely affect students as they attempt to lay a foundation for financial and social stability into adulthood with limited resources and incomplete or incorrect information. While most students do not accurately estimate the costs of college, low-income and first-generation students are more likely to be less accurate in estimating their college costs (Avery &

Kane, 2004; Horn, Chen, & Chapman, 2003). Under-alignment, coupled with students' incorrect assumptions about their resulting income from a chosen college or career pathway, can lead to financial debt, lengthened or incomplete college degree attainment, and diminished lifetime earnings (Kim, Klager & Schneider, 2019; Schmitt-Wilson & Faas, 2016).

2.2.2 The consequence of misalignment and limited alignment knowledge

Most of the problems inherent in misalignment have looked at special populations and their access and knowledge regarding college choices. Low-income and racial/ethnic minority students remain the most marginalized population with limited access to higher education (Oymak, 2018). Despite multiple interventions, students in families with limited economic and social resources attend postsecondary institutions in disproportionately lower numbers than more advantaged students (McFarland et al., 2019). Students with limited resources are also less likely to enroll in college within one year of high school graduation or stay in college until they complete their degrees (in either two- or four-year institutions). These students represent a much smaller proportion of those who enroll in selective or competitive four-year institutions than their more advantaged counterparts. Although two-year institutions could be a more promising, less costly option for students with limited economic resources, research suggests that students enrolling at a two-year institution with misaligned ambitions faced a significantly decreased probability that they will eventually transfer and attain a bachelor's degree than if they had started college at a four-year institution (Schudde & Brown, 2019).

Students whose parents never attended college (first-generation students) represent another at-risk group whose college enrollment is lower than it was five years ago, when considering the total number of age-eligible first-generation students

(Campbell & Wescott, 2019). They also face similar challenges in persisting and completing their college degrees (Cataldi, Bennett, & Chen, 2018). These students are also at a disadvantage with respect to information about college preparation and the application process, college costs, and potential financial aid options. Even though most students do not accurately estimate the costs of college, low-income and first-generation students are more likely to underestimate college costs. Misalignment between education and career choices has posed a greater threat to underserved youth than previously thought (Deil-Amen & DeLuca, 2010; Sabates, Harris, & Staff, 2011).

Students with limited alignment knowledge tend to have inadequate academic preparation and an unrealistic understanding of the education and career opportunities for their future lives (Lowry, 2017). Many students—especially those whose career goals are unaligned with their college choices—are likely to incur substantial personal financial debt and be unable to complete their degrees (Robb, 2017; Robb, Moody, & Abdel-Ghany, 2012). Low-income minority students with no alignment knowledge have severe long-term consequences for job opportunities, wages, health and well-being in adulthood (Schneider & Young, 2019, Muskens, Frankenhuis, & Borghans, 2019; Reynolds & Baird, 2010). All these studies underscore the importance of low-income and minority students having a coherent, aligned plan between their educational, occupational, and financial aspirations as they transition out of high school.

2.2.3 Aligned ambition

The relationship between educational expectations and occupational choices has been referred to as alignment and signifies coherence between a desired career and the requisite education necessary to obtain it (Schneider & Stevenson, 1999). Aligned ambitions are an important part of the strategic college planning process, as they encourage students to make purposeful and strategic choices regarding their education

and career pathway. In more advantaged schools, there are multiple opportunities for students to gain information about college and future occupational choices that greatly enhance their ability to align their future ambitions with educational requirements. Sometimes referred to as the "school milieu," these environments contain hidden messages discussed among peers, teachers, and counselors about what the bar is for college admission test scores, advanced level course selection, and even helpful resources about college financial aid—all sources of knowledge that would enhance a student's ability to properly align their future ambitions for college or work. (Avery, Howell, & Page, 2014). The knowledge contained in the school milieu, while critical, is often unavailable to low-income and minority students, resulting in ambitious but unaligned pathways towards college and career goals.

Despite several large interventions designed to support low-income and minority students (Stipanovic, Stringfield, Witherell, 2017; Schneider, Broda, Judy, & Burkander, 2013; Carnevale, & Desrochers, 2002; Ryken, 2006), the proportion of historically underserved students accessing higher education institutions and completing their degrees has changed little over the last decade (Cataldi, Bennett, & Chen, 2018). What is needed are experiments with new interventions, especially regarding alignment knowledge, to assist more young adults with making strategic choices about their college and career ambitions. One key missing part of that process is how to bring this crucial knowledge beyond school counseling services or websites that could expedite access to education and career-related information and decision-making processes.

2.2.4 Smartphone technology in education

Smart phones have become increasingly pervasive in adolescent daily life; approximately ninety-five percent of teenagers own or have access to smartphones (Anderson & Jiang, 2018) which they use for a variety of different purposes such as

communication, information and entertainment. However, mobile phone apps can serve as another channel to access college and career information not readily available in formal classrooms, career counseling, or informal settings outside of school. The development of "gamified" apps can provide educators with innovative tools to promote student engagement in learning activities (Luna-Nevarez & McGovern, 2018). Gamification typically involves the use of game elements to motivate users to perform tasks effectively aiming at psychological and behavioral changes (Herodotou, 2018; Klímová, 2018; Xiangming & Song, 2018). Recent research shows that mobile game applications (apps), can become an innovative tool to promote student engagement in learning activities and impact their academic, emotional and social learning (Singh, 2018; Pechenkina, Laurence, Oates, Eldridge & Hunter, 2017; Williamson, 2017). We expect that gamified mobile apps could present another channel for realistically shaping students' educational expectations and occupational aspirations.

Although there are multiple educational programs for supporting students in planning for their college pathways, few have been developed specifically for smartphone use or designed in a gamified platform. Given the pervasiveness of mobile technology among adolescents (PEW Research Center, 2017), gamified apps could be a cost-effective tool, quickly disseminating information with instant feedback. Given the complex decisions adolescents face when deciding their next steps after high school graduation, mobile games can attract students to learn about college and career pathways through a medium that can increase knowledge and at the same time is personally rewarding and enjoyable.

3. Init2Winit design and point system

3.1 Init2Winit game design

Recognizing the prevalence of smartphone use among youth, the challenge was building an information game that students could play numerous times and was grounded in earlier research on what steps they needed to make a successful transition from high school to postsecondary school and the labor force (Schneider & Young, 2019). Using mobile technology, Init2Winit employs a dynamic game design for students to visualize themselves in various career/college pathways and learn alignment knowledge through gameplay.

The logic behind this game design is that this thought-provoking but personalized tunnel exploration can result in virtually thousands of different outcomes and, ultimately, learning experiences about an imminent but often confusing process in postsecondary planning for low-income and minority students. In addition, Init2Winit provides a valuable database for educators or school counselors to easily engage students who may not be invested in their college and potential career choices, or who are unsure about which education credential they need to obtain a desired career.

3.2 Front-end, Back-end and Onboard

Init2Winit has two games embedded in the current setting. The first tunnel allows the player to explore their career. After the player selects the career tunnel, she/he is presented with a "career" choice screen, see Figure 3. This screen employs a self-directed exploration of potential careers/jobs; there are more than 18 occupational fields containing 50 discrete job titles from which students can choose. The database comes from O*NET, a comprehensive database of occupational competency profiles and the Bureau of Labor Statistics. When students scroll down, they are shown the sounds and photographs corresponding with each sub-field and job (National Center for O*NET Department, 2019), simulating a game-like experience to enhance enjoyment. Students advance to the next section in the tunnel after making their field/job choice. Choices are

tracked in real-time using a built-in iOS and Android information notification system and updated every five minutes.

[Insert Figure 3 here]

The next screen, "education", challenges players to choose one educational requisite from several different options (e.g., a 4-year college or 2-year college) that aligns with their previous career choice, see Figure 3. The "education" screen is the students' first opportunity in this tunnel to align the related constructs of career and college in their virtual pathway—one of the main goals of the game. Players then advance to the third section of the career tunnel after making an educational choice they believe best aligns with their previous career selection.

The third section of the career tunnel is the "earnings" screen, see Figure 3. After a player has made his/her best estimate of aligning a chosen career with college expectations in the first two sections of the tunnel, the final game challenge is to predict a likely salary for the chosen pathway. Students are offered four different salary ranges and tasked with correctly choosing which one is the most realistic earnings projection for their virtual pathway. The "earnings" screen is the students' second opportunity to align multiple constructs within their personalized virtual career pathway through the career tunnel.

3.3 Init2Winit game categories and scoring

To measure alignment knowledge, game activities were classified into three alignment categories: (1) Alignment, (2) Misalignment, (3) and No-Alignment. Alignment knowledge is categorized into three distinct scenarios for which the players receive different scores. These categories are described below.

3.3.1 Alignment knowledge score: 2 points

Students who correctly match career plans, educational expectations, and salary projections were considered to have full alignment knowledge regarding their future ambitions. Figure 3 shows a student playing in the career tunnel who chooses a counseling career, plans to earn a four-year college degree, and predicts a $45 to $60K yearly salary. This student will earn the full alignment score of 2 points--one point for correctly aligning the amount of education typically needed to be a school counselor and one point for correctly choosing an appropriate salary for a counselor. Students can earn full alignment scores through a myriad of different combinations; aligned students are also those who do not expect to receive a four-year degree, but plan to attend a technical or trade school after high school and earn $35,000 as a hairstylist.

3.3.2 Misalignment knowledge score: 1 point

Students whose career plans correctly corresponded to either their educational expectations or salary projections (but not both) were considered to have misaligned knowledge, as they were unable to correctly align all three components in their virtual career pathway. Both over- and under-aligned game play indicates misalignment. Under-aligned students can identify a job and correctly choose a realistic salary range, but underestimate or are unaware of the educational requirements for the position. Likewise, an over-aligned student could correctly identify a desired career with matching salary but overestimate the educational requirements for the job. Figure 4 is an example of under-aligned gameplay: the student chooses a teaching career and is uncertain about educational plans, but correctly predicts earning a $45 to $60K yearly salary, ultimately earning a score of 1 point. This student has been rewarded 1 point because of the job-to-salary choice, not the job-to-education choice.

[Insert Figure 4 here]

3.3.3 No alignment knowledge score: 0 points

Many adolescents have unrealistic ambitions regarding their future occupational aspirations and the education needed to attain these goals, especially for students from low-income families. Figure 5 is an example of no-alignment gameplay in which the student does not correctly identify the required education or potential income of a doctor. Students with no alignment knowledge earn 0 points in the career tunnel.

[Insert Figure 5 here]

4. Methods

4.1 Procedures

Several high schools, all of which had participated in other college interventions, expressed a desire to be a part of this study (see, Schneider 2014). This resulted in contacting and involving two purposely selected high schools—one in an urban and the other in a rural area. Both schools had lower than the state average in college enrollment rates and high school students whose test scores were lower than the state average and whose families were less likely to have advanced college degrees. The urban school has a population of 84% economically disadvantaged students and 72% minority students. The rural school has a population of 40% economically disadvantaged students and most students are white (Michigan Department of Education, 2019).

4.2 Study analytic sample

The final analytic sample included 481 students who completed fall and spring surveys with valid college plans, race/ethnicity, school GPA, and parents' level of education. Among 481 students, 98 student users activated their mobile app account with valid mobile app records. For the second and third outcome, the analytical sample included 314 students who had fall and spring survey data with valid educational aspirations and other covariates. Among 314 students, there were 64 Init2Winit users.

[Insert Table 1 here]

This study includes 98 Init2Winit users in the analysis. In Table 1, nearly 75 % of users are minority students with a high school GPA between 2.5 and 3.0 and whose parents have less than a college education (66% of parents have less than college education). The overwhelming majority of the mobile app users were in 11th grade, and thus there were no grade level distinctions.

Mobile app usage data was obtained from the student phones and housed on a secured server. A program recorded the frequency of plays per day, the duration of each play, and the number of plays a student took to obtain the correct aligned answer for a specific job. The Daily Active Users (DAU) displays the number of unique users who record at least one play of Init2Winit from May 3rd to May 29, 2019 which can be found in Figure 6. In Figure 6, the numbers in each bar represent the total number of individual users per day.

[Insert Figure 6 here]

4.3 Measures

4.3.1 Dependent variables

College plans indicate whether a student planned to enroll in postsecondary education after high school graduation. Specifically, in a survey administered during the spring semester of the 2018–2019 school year, students were asked, "After graduating from high school, what is your plan?" Options included: attending a 2-year college, 4-year college, vocational school, technical or trade school, joining the military, or entering the labor force. Less than 5 % of CAP students planned to enter the military. This variable (college plan) was collapsed into two categories: 1 for students planning to enroll in a 4-year college, and 0 for students who enroll in a 2-year college or plan to enter the military, a trade school, or the workforce.

Students' educational expectations were measured by their response to the question, "How far in school do you think you'll get?" in a survey administered in the fall semester of the 2018–2019 school year. The scale ranges from 1 (less than high school completion) to 7 (complete a Ph.D., M.D., law degree, or other high-level professional degree). A higher value indicated students' higher educational expectations. They were given a broad choice of education they would like to obtain if there are no barriers (e.g., Ph.D., master, bachelor, vocational school, associated degree, high school degree, GED). One of the possible response alternatives was "not decided yet, do not know," which was chosen by 9 and 6 percent of male and female students and excluded in the final analytic sample. Based on this variable, we also generated a binary variable that indicates whether students have college-going aspirations and a gain score of educational aspirations from T1 (fall) to T2 (spring).

4.3.2 Key independent variables

Level of alignment knowledge measures the number of alignment-play (details see the section 3.3.1: alignment-play measures the number of the full alignment score of 2 points) during the beta testing for each user. Alignment knowledge indicates job-specific knowledge when a student chooses a job and then correctly aligns their educational plans and knowledge about potential annual earnings for that job. The higher the number of alignment-play between education ambitions and career pathways, the more knowledge students had between education and career pathways. This indicator measures students' deeper understanding of their ambitions in specific fields and educational requirements for a specific job. When users played on the same job repeatedly, they were excluded from this analysis. In our case, 20 % of users had no aligned play during beta-testing and 80% of users had at least one aligned play during beta-testing (see Table 1).

The number of mobile app plays per day was measured by the average number of "per user" "per day." This variable is a user-specific variable and the descriptive statistics are reported in Table 1. On average, 20 % of users play one time per day, 26 % of users play two times per day and 35 % of users play 3-4 times per day.

4.3.3 Covariates

Parent education was measured by students' responses to the question, "What is the highest level of education any of your parents has completed?" The scale ranges from 1 (less than high school) to 4 (college completion and beyond).

Gender was coded as a dummy variable (female =1; male =0); race and ethnicity include four groups of students' backgrounds: non-Hispanic White, Black, Hispanic, Asian/Others.

5. Data analysis

5.1 Analytic strategy

The goal of this study is to obtain evidence that would allow for causal attributions indicating that high school students learned the alignment knowledge and increased their college aspirations and plans because of playing the game. Students were invited to voluntarily activate the Init2Winit gamified learning program. These volunteer participants comprise our treatment group; the control group was estimated with propensity matching using non-participating students in the same high schools. Students who participate in Init2Winit gameplay are likely different from those who did not activate the Init2Winit gamified learning program.

To address the potential selection bias with the volunteer sample and estimate a causal indication of Init2Winit gameplay on students' college-going attitudes, we first conducted matching procedures and then made several statistical adjustments to achieve baseline equivalence between treatment and control group regarding a set of covariates

(Abadie and Imbens 2012; Morgan & Winship, 2015; Schneider et al., 2007). After reaching baseline equivalence, we then estimated the treatment effect using STATA package of *teffects psmatch*.

Two analyses were conducted; in the first, 98 treatment students who played the game and 383 controls of all who had fall and spring survey after propensity score matching. In the second analysis there were 64 treatment students with completed information (including covariate, ie. college plans, race/ethnicity, school GPA and parents' level of education). The control sample is 250 students who did not participate in the program but had completed both fall and spring survey. In the first analysis, the dependent measure was 4-year college plans whereas in the second analysis, the dependent variable is college aspirations and aspiration gain score.

5.2 Propensity score matching

5.2.1 Propensity score matching steps

Propensity score matching is to establish the baseline equivalence by assigning to each student a propensity score defined as the likelihood that students activated Init2Winit given a set of covariates in the baseline model. We define PS (x) as:

$$\text{PS}(x_i) = \text{p}(T_i=1 \mid \text{X} = x_i) \quad (1)$$

Where T_i=1 represents a likelihood of being assigned to a treatment group, and X is the set of observed covariates.

Step 1: Differences in observation data

Before matching, we report the descriptive statistics between the treatment and control group differences on all covariates in Table 2 and Table 3. This allows us to compare the group difference before and after matching. We use a standardized mean to show the difference.

Step 2: Generating propensity scores.

We employ a logistic regression to identify each student's propensity of being in the treatment or control condition, i.e., the probability of activating Init2Winit:

$$\text{Log}\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki}$$

Where P is the estimated propensity score for student i. 1 through k are estimated coefficients, X are ranges of observed background characteristics including school GPA, educational aspirations in fall semester, parents' level of education, gender, race and ethnicity. In other words, conditional on propensity score, covariates would be equally distributed between treatment and control group, allowing the observational studies to mimic some of the characteristics in the randomized experiments.

Step 3: Assessing balance with matching. We employed three tests to assess the quality of the match (Rubin, 2001). The first is to calculate standardized mean differences of the covariates between matched pairs after propensity score matching. The standardized means after matching were between –.08 and +.09, markedly smaller than the acceptable range of –.1 and +.1, and we found that none of the covariates were statistically significant. This indicator shows a balanced sample between the matched Init2Winit users and non-users (See Table 2 and Table 3). The second test measures the density between the treatment and control measures, which is shown in Appendix A and Appendix B. The visual difference shows considerable overlapping covariates between the two samples which validates our method to achieve balance. The third method is to calculate the ratio of the variances of the propensity scores in the two groups. Rubin (2001) suggests that the range should be between 0.5 and 2.0. The range in our sample was between 0.8 and 1.2. Most of them are nearly 1.0, also indicating an appropriate balance for the matching process.

5.2.2 Estimate treatment effect

Our primary goal is to also detect the average treatment of Init2Winit on all students, i.e., the average effect of treatment (ATE), even those who did not play Init2Winit at all. This effect provides additional information on what the treatment effect would be if all students adopted Init2Winit in the three weeks of activation. ATE is the expected difference score on an outcome between the treated and the untreated group for each individual student in equation (2).

$$\text{ATE}=E(Y_1 - Y_0) \quad (2)$$

The secondary goal is to detect the average treatment effect of Init2Winit users who played the game, that is the average effect of treatment on the treated (ATT). In our case, activating Init2Winit is not randomly assigned. Thus, it is important to know the ATT by comparing students' educational aspirations improvement as an estimate of what would have happened if these same students had not used Init2Winit.

The ATT equation identified as:

$$\text{ATT}=E(Y_1|T=1)-E(Y_0|T=1) \quad (3)$$

where $E(Y_1|T=1)$ represents the probability that outcome Y, or the observed educational aspirations of students, will occur for those receiving treatment T, actual gameplay of the Init2Winit app. The right-hand side, $E(Y_0|T=1)$, represents the probability that outcome Y would have occurred if the same students had not used Init2Winit. In this study, this estimate is based on hypothetical aspirations outcomes for the same students if they had not played Init2Winit. This is the counterfactual estimate.

6. Results

6.1 Descriptive statistics

Table 2 presents descriptive statistics for the matching variables and the first outcome of whether a student had a 4-year college plan to determine if any statistically significant

differences exist between Init2Winit users and non-users before and after matching. There was imbalance in the proportion of users versus non-users as white (20% versus 32%, p=.02) and other racial groups, including Middle Eastern or multi-racial (40% versus 26%, p=.006). After matching, the standardized mean difference across all covariates was very small and not statistically significant, indicating approximate balance between users and non-users. For example, the raw difference between treatment and control group before matching is 5 % in female and 12% in white. After propensity score adjustment, the difference between treatment and control becomes 1.2% in female and 1.5% in white. We also generated a balance density plot for parent education over propensity score before and after matching, as shown in Appendix A.

[Insert Table 2 here]

Table 3 presents additional descriptive statistics before and after matching the second and third outcomes--of whether a student had college-going aspirations in spring (T2) and gained aspirations from fall (T1) to spring (T2). As expected, there was imbalance in several covariates such as the proportion of users who are white and nonwhite; however, after matching there were no differences. Students' GPAs also showed a slight difference between users and non-users (p=.07). After matching, no significant differences remained between the two groups. The balance box plot on GPA before and after matching is shown in Appendix B. Moreover, there were no statistically significant effects between users and non-users on the pretest with respect to whether students had college-going aspirations at T1 and educational aspirations at T1. We reported results of multivariate models in Appendix C and Appendix D. Our multivariate regression models show significant treatment effects for playing Init2Winit on college-going aspirations and the gain of educational aspirations from T1 to T2 without accounting for selection bias.

[Insert Table 3 here]

6.2 Treatment effect estimation

Table 4 shows the average treatment effect (ATE) for three outcomes. ATE offers the estimated treatment effect of Init2Winit on the outcome if all students were randomly assigned to use Init2Winit. After propensity score adjustment, Model 1 results show that when all students played the game, the average chance of having a 4-year college plan in T2 is higher by 18 percentage points compared to non-users. Model 2 focuses on the second outcome of college-going aspirations. After propensity score adjustment, the average chance of having a college-going plan in T2 is higher by 7 percentage points if all students played Init2Winit compared to non-users. Model 3 shows the gain in educational aspirations. Results suggest only a slightly significant average treatment effect for Init2Winit on the gain in educational aspirations (p=.10).

[Insert Table 4 here]

Table 5 shows the average treatment effect for treated (ATT) for three outcomes. ATT offers the estimated treatment effect of app users who played Init2Winit compared to the same students if they did not play Init2Winit. After propensity score adjustment, Model 1 shows that Init2Winit users having a 4-year college plan in T2 are higher by 15 percentage points compared to the same students if they did not play Init2Winit. In addition, Model 3 also shows that Init2Winit users' gains in educational aspirations from T1 to T2 is .24 points greater than the same students if they did not play the game. No significant treatment effect was found for Init2Winit users on college aspirations in Model 2.

[Insert Table 5 here]

6.3 Robustness check

In the previous section, we conducted propensity score matching to reduce selection bias and to make inferences about the association between Init2Winit users and their 4-year college plans, college-going aspirations, and increases in educational aspirations. Our matching process produced a balanced sample, with control group equivalence on all covariates; however, we recognize there could be other factors that encourage students to have higher educational expectations, changes in college plans, and changing patterns over the course of a school year.

To ensure that the findings were robust regarding these analytic decisions, we conducted several sensitivity checks. We employ the techniques of Frank et al. (2013), to invalidate our inference in the first outcome in Table 4, 36 percent of the estimated effect of playing the app on having a plan to attend a 4-year college going would have to be due to biases such as omitted alternative explanations (calculations conducted at *Konfound-it.com* using an estimated effect of 0.18, standard error of .059, sample size of 481 and 9 covariates). In other words, to invalidate our inference, one would have to replace 36 percent (about 171 students) with cases for which there was no relationship between Init2Winit users and students' chance of having a 4-year college plan in T2 compared to nonusers.

To invalidate our inference in the second outcome in Table 4, 39 percent of the estimated effect of playing the app on changes of college-going aspirations would have to be due to biases such as omitted alternative explanations (calculations using an estimated effect of 0.078, standard error of .024, sample size of 314, and 9 covariates). In other words, to invalidate our inference, one would have to replace 39 percent of players (about 124 students) with cases for which there was no relationship between Init2Winit users and students' T2 college-going aspirations compared to nonusers.

For treatment effect on Init2Winit users in Table 5, to invalidate our inference for the average treatment effect for treated in whether these students had 4-year college-going plans in T2, 19 percent of the estimated effect of Init2Winit users would have to be due to a bias such as omitted alternative explanations (calculations using an estimated effect of 0.150, standard error of .062, sample size of 481, and 9 covariates). Importantly, to invalidate our inference for the average treatment effect for treated in the gains of educational aspirations from T1 to T2, 29 percent of the estimated effect of Init2Winit users would have to be due to bias such as omitted alternative explanations. In other words, to invalidate our inference one would have to replace 93 students with cases for which there was no relationship between Init2Winit users and the improvement of educational aspirations.

6.4 Users' improvement: the effect of alignment knowledge and number of plays

To further examine whether Init2Winit users' improvements in educational aspirations and 4-year college plans are attributed to their level of alignment knowledge and number of game plays, results were shown in Table 6 and Table 7. The result illustrates substantial gains of educational aspirations from T1 to T2 are associated with alignment knowledge between career and education ($p<.05$) in Table 6. For the number of game plays, we found no associations between number of plays and players' 4-year college plans, college aspirations, and the improvements in educational aspirations after controlling for players' prior educational aspirations and 4-year college plans in Table 5. However, we found a small positive association between 4-year college plans and the level of alignment knowledge ($p <.10$).

[Insert Table 6 here]

[Insert Table 7 here]

7. Discussion

The purpose of this study was to examine whether playing Init2Winit has an effect on the changes of students' 4-year college plans, college-going aspirations and increases in those educational aspirations. This study is important because Init2Winit is a mobile application created to increase low-income and minority students' awareness of and access to college knowledge and career planning. Given the level of alignment knowledge for various college and career pathways that students explored during three weeks of game playing, we used the propensity score matching approach to examine whether game play is associated with increased 4-year college planning, college-going aspirations, and educational aspirations from fall (T1) to spring (T2).

There are several important findings. First, our results show that Init2Winit users are about 18 percentage points more likely to have plans to attend a 4-year college compared to non-users if *all students were randomly assigned to use Init2Winit*. In addition, Init2Winit users are about 7 percentage points more likely to have college-going aspirations after the propensity score adjustment. Second, we also found that Init2Winit users are more likely to have a 4-year college plan in T2 by 15 percentage points compared to the estimates of *similar students* who did not play Init2Winit. Our results also reveal that Init2Winit users increase their educational aspirations from T1 to T2 by .24 points compared to the estimates of *similar students* who did not play the game. However, we did not find the treatment effect of treated in the college-going aspirations.

There are several possible explanations for this inconsistency between ATE and ATT in the outcome of college-going aspirations. First, our hypothesis about the effect of playing Init2Winit app assumes that students' college-going aspirations are influenced by alignment knowledge. It is possible that other factors, such as financial issues or college fit, may outweigh students' college-going aspirations, in which the

relationship between users' alignment knowledge and college-going aspirations may be less important (Campbell & Wescott, 2019; Robb, 2017). Second, it is also possible that most of the Init2Winit players had college-going aspirations in the fall semester. Therefore, the changes in college-going aspirations before and after playing Init2Winit were not necessarily influenced by alignment knowledge. Third, our results also show that Init2Winit users' level of alignment knowledge between career and education requirements is positively associated with increases in educational aspirations. Specifically, Init2Winit players who were successful in matching their pathways from education to career are more likely to improve their educational aspirations than their counterparts with lower or no alignment knowledge.

These results are comparable to other mobile app interventions for low-income high school students in math (Kim et al., 2011), science learning (Drayton et al, 2010), and motivation improvement (Rau, Gau & Wu, 2011). Our findings extend previous work on smartphone app development in educational technology by demonstrating the improvement of educational aspirations and 4-year college plans after accounting for the selection bias of volunteer participants in this observational study.

It is worth noting that nearly 20% of mobile app users (39 users) did not receive any points during the gameplay, indicating some treatment students still have limited knowledge between career, education, and income alignment. This means that certain low-income, Minority, or first-gen students still encounter difficulties in aligning their future ambitions and career endeavors with the requisite education. While research correctly compels educators to maximize these learning opportunities for students through school counselors, professional development or personal experience (West & Volsoo, 2013; Mouza & Barrett-Greenly, 2015), innovations like Init2Winit can prove to be another stand-alone source of information and guidance for students' agency and

ownership. As more young people pursue postsecondary education and professional jobs in transition into adulthood, information about the desired occupations, salary and the alignment knowledge from school to work grow in importance for young people's ability to make a realistic plan, take strategic action, and choose an effective decision.

8. Limitations

Despite its ability to capitalize on year-long longitudinal data within a short intervention period, the current analysis has some limitations. First, we cannot draw causal conclusions from these analyses. We addressed this concern by employing propensity score matching and control variables. However, without a randomized control trial, it is difficult to initially estimate possible unobserved factors between users and non-users. Second, our analysis only compares students in our study who completed both fall and spring survey. Even though we have a high survey response rate in two schools, those students who failed to finish *both* surveys were excluded from the analyses. Third, we do not have specific family socioeconomic data (e.g., family income or parents' occupation) prior to high school which may affect parents' and students' decision to enroll in their current high school. Including students' earlier school achievement or family-specific characteristics may increase or maximize the strength of our findings.

9. Conclusion

Init2Winit is a gamified mobile application designed to increase students' alignment knowledge between college, career, and salary expectations. Given the universal nature of mobile technology, this game has the ability to reach an unprecedented number of low income and minority students and afford them with increased understanding of how to align and navigate their college and career ambitions that they might not have otherwise. Init2Winit can serve multiple purposes across the diverse fabric of college and career readiness, including transitional awareness, engagement, and informed

planning for college/career trajectories. This particular study found that students who played Init2Winit significantly increased their 4-year college plans and educational aspirations across the span of a school year compared to non-players, reassuring potential investors, buyers, and users of its worth and applicability to today's youth. It is imperative that research such as this continues to recognize and address the increasing complexities and costs involved with curating a well-informed pathway following high school graduation.

Acknowledgements

The authors want to thank Lindsey Young, Amieris Lavender, and Goun Choi for their assistance with an earlier data collection that contributed to this study. This work has been supported by the National Science Foundation under Grant No. 1316702 and No. 1661236. The opinions expressed do not necessarily reflect the views of the Foundation.

Declaration of Interests

References

Abadie, A., & Imbens, G. W. (2012). A Martingale Representation for Matching Estimators. Journal of the American Statistical Association, 17 (498), 833-843.

Anderson, M. & Jiang, J. (2018). Teens, Social Media & Technology. Pew Research Center. Washington, D.C. Retrieved from https://www.pewresearch.org/internet/2018/05/31/teens-social-media-technology-2018/.

Avery, C., & Kane, T. J. (2004). Student perceptions of college opportunities. The Boston COACH program. In College choices: The economics of where to go, when to go, and how to pay for it (pp. 355-394). University of Chicago Press.

Avery, C., Howell, J. S., & Page, L. (2014). A review of the role of college counselling, coaching, and mentoring on students' postsecondary outcomes [Research brief]. College Board. Retrieved from the ERIC database. (ED556468)

Bailey, M., and S. Dynarski. (2012). Inequality in Postsecondary Education. In G. Duncan and R.Murnane (eds.), Whither Opportunity? Rising Inequality, Schools, and Children's Life Chances. Russell Sage Foundation.

Bettinger, E., Long, B. T., Oreopoulos, P., & Sanbonmatsu, L. (2012). The role of application assistance and information in college decisions: Results from the H&R Block FAFSA experiment. The Quarterly Journal of Economics, 127(3), 1205–1242. doi:10.1093/qje/qjs017

Campbell, T., & Wescott, J. (2019). Profile of undergraduate students: attendance, distance and remedial education, degree program and field of study, demographics, financial aid, financial literacy, employment, and military status: 2015–16. Washington, D.C. Retrieved from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2019467.

Carnevale, A. P., & Desrochers, D. M. (2002). The Missing Middle: Aligning Education and the Knowledge Economy. Journal for Vocational Special Needs Education, 25(1), 3-23.

Cataldi, E. F., Bennett, C. T., & Chen, X. (2018). First-Generation Students: College Access, Persistence, and Post bachelor's Outcomes. Stats in Brief. NCES 2018-421. National Center for Education Statistics.

Chen, I. C., Rocha-Beverly, C., & Schneider, B. (2020). Alignment of educational aspirations and career plans in high school with Mobile app technology. Education and Information Technologies, 1-19.

Cook, Thomas D., William R. Shadish, W.R., & Wong, V.C. (2008). Three conditions under which experiments and observational studies produce comparable causal estimates: New findings from within-study comparisons. Journal of Policy Analysis and Management 27:724-750.

Deil-Amen, R., & DeLuca, S. (2010). The underserved third: How our educational structures populate an educational underclass. Journal of Education for Students Placed at Risk, 15(1-2), 27-50.

Drayton, B., Falk, J. K., Stroud, R., Hobbs, K., & Hammerman, J. (2010). After Installation: Ubiquitous Computing and High School Science in Three Experienced, High-Technology Schools. The Journal of Technology Learning and Assessment, 9(3). Retrieved from https://ejournals.bc.edu/index.php/jtla/article/view/1608

Frank, K.A., Maroulis, S., Duong, M., and Kelcey, B. (2013). What would it take to Change an Inference?: Using Rubin's Causal Model to Interpret the Robustness of Causal Inferences. Education Evaluation and Policy Analysis 35, 437-460.

Herodotou, C. (2018). Young children and tablets: A systematic review of effects on learning and development. Journal of Computer Assisted Learning, 34(1), 1-9.

Horn, L. J., Chen, X., & Chapman, C. (2003). Getting Ready to Pay for College: What Students and Their Parents Know about the Cost of College Tuition and What They are Doing to Find out. (NCES 2003-030). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2003030.

Kim, P. E. Buckner, H. Kim, T. Makanya, N. Taleja, V. Parikh (2011). A comparative analysis of a game-based mobile learning model in low-socioeconomic communities of India. International Journal of Educational Development, 32, 329-340, 10.1016/j.ijedudev.2011.05.008

Kim, S., Klager, C., & Schneider, B. (2019). The effects of alignment of educational expectations and occupational aspirations on labor market outcomes: Evidence from NLSY79. The Journal of Higher Education, 90(6), 992–1015. doi:10.1080/00221546.2019.1615333

Klímová, B. (2018). Mobile phones and/or smartphones and their apps for teaching English as a foreign language. Education and Information Technologies, 23(3), 1091–1099. doi:10.1007/s10639-017-9655-5

Lowry, K. (2017) Community College Choice and the Role of Undermatching in the Lives of African Americans, Community College Journal of Research and Practice, 41(1), 18-26.

Luna-Nevarez, C., & McGovern, E. (2018). On the use of mobile apps in education: The impact of digital magazines on student learning. Journal of Educational Technology Systems, 47(1), 17–31.

McFarland, J., Hussar, B., Zhang, J., Wang, X., Wang, K., Hein, S., Diliberti, M., Forrest Cataldi, E., Bullock Mann, F., & Barmer, A. (2019). *The Condition of*

Education 2019 (NCES 2019-144). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved July 19, 2019, from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2019144.

Michigan Department of Education. (2019). School Characteristics. Retrieved from https://www.mischooldata.org/Default3.aspx

Morgan, S., & Winship, C. (2015). Counterfactuals and Causal Inference. New York: Cambridge University Press.

Mouza, C. & Barrett-Greenly, T. (2015). Bridging the App Gap: An Examination of a Professional Development Initiative on Mobile Learning in Urban Schools. Computers & Education, 88, 1-14. 10.1016/j.compedu.2015.04.009.

Muskens, M., Frankenhuis, W. E., & Borghans, L. (2019). Low-income students in higher education: Undermatching predicts decreased satisfaction toward the final stage in college. Journal of Youth and Adolescence, 48(7), 1296–1310. https://doi.org/10.1007/s10964-019-01022-1

National Center for O*NET Development. Job zone. O*NET OnLine. Retrieved from https://www.onetonline.org/find/zone

Oymak, C. (2018). High School Students' Views on Who Influences Their Thinking about Education and Careers. Stats in Brief. NCES 2018-088. National Center for Education Statistics.

Pechenkina, E., Laurence, D., Oates, G., Eldridge, D., & Hunter, D. (2017). Using a gamified mobile app to increase student engagement, retention and academic achievement. International Journal of Educational Technology in Higher Education, 14(1), 1-12.

Perry, B., Martinez, E., Morris, E., Link, T., & Leukefeld, C. (2016). Misalignment of career and educational aspirations in middle school: Differences across race, ethnicity, and socioeconomic status. Social Sciences, 5(3), 1-10.

Pew Research Center. (2017). Mobile fact sheet. Washington, D.C: Retrieved from http://www.pewinternet.org/fact-sheets/mobile

Rau, P.L.P., Gau, Q., Wu, L.M. (2008) Using mobile communication technology in high school education: motivation, pressure, and learning performance. Computers & Education, 50, 1-22, 10.1016/j.compedu.2006.03.008

Reynolds, J. R., & Baird, C. L. (2010). Is There a Downside to Shooting for the Stars? Unrealized Educational Expectations and Symptoms of Depression. American Sociological Review, 75(1), 151–172. https://doi.org/10.1177/0003122409357064

Robb, C. A. (2017). College student financial stress: Are the kids alright? Journal of Family and Economic Issues, 38(4), 514–527.

Robb, C. A., Moody, B., & Abdel-Ghany, M. (2012). College student persistence to degree: The burden of debt. Journal of College Student Retention: Research, Theory & Practice, 13(4), 431–456.

Rubin, D.B. (2001). Using Propensity Scores to Help Design Observational Studies: Application to the Tobacco Litigation. Health Services & Outcomes Research Methodology, 2, 169–188. https://doi.org/10.1023/A:1020363010465

Ryken, A. (2006). " Goin'Somewhere": How Career Technical Education Programs Support and Constrain Urban Youths' Career Decision-Making. Career and Technical Education Research, 31(1), 49-71.

Sabates, R., Harris, A. L., & Staff, J. (2011). Ambition gone awry: The long-term socioeconomic consequences of misaligned and uncertain ambitions in adolescence. Social science quarterly, 92(4), 959-977.

Salkind, N. J. (2010). Encyclopedia of research design. Thousand Oaks, CA: SAGE Publications, Inc. doi: 10.4135/9781412961288

Schmitt-Wilson, S., & Faas, C. (2016). Alignment of educational and occupational expectations influences on young adult educational attainment, income, and underemployment. Social Science Quarterly, 97(5), 1174–1188. doi:10.1111/ssqu.12244

Schudde, L., & Brown, R. S. (2019). Understanding Variation in Estimates of Diversionary Effects of Community College Entrance: A Systematic Review and Meta-analysis. Sociology of Education, 92(3), 247–268. https://doi.org/10.1177/0038040719848445

Schneider, B., Kim, S., & Klager, C. (2017). Co-Development of education aspirations and postsecondary enrollment especially among students who are low income and minority. Research in Human Development, 14 (2), 143-160.

Schneider, B., & Stevenson, D. (1999). The Ambitious Generation: America's Teenagers, Motivated but Directionless. Yale University Press.

Schneider, B, Carnoy, M., Kilpatrick, J., Schmidt, W., & Shavelson, R. (2007). Estimating Causal Effects Using Experimental and Observational Designs. Amer Educational Research Assn.

Schneider, B., & Young, L. (2019). Advancing workforce readiness among low-income and minority high school students. In Oswald, F. L., Behrend, T. S., & Foster, L. L., (Eds.). Workforce readiness and the future of work. New York, NY: Taylor & Francis.

Schneider, B. (2014). The college ambition program: A realistic transition strategy for traditionally disadvantaged students. Educational Researcher, 44(7), 394–403.

Schneider, B., Broda, M., Judy, J., & Burkander, K. (2013). Pathways to college and STEM careers: Enhancing the high school experience. New directions for youth development, (140), 9-29.

Singh, G. (2018). 29 app store stats 2018–19 that proves Apple's uprising growth trend. Retrieved from appinventiv website: https://appinventiv.com/blog/apple-app-store-statistics/e

Steiner, P. M., Cook, T. D.,. Shadish, W. R, & Clark, M. H. (2010). The Importance of Covariate Selection in Controlling for Selection Bias in Observational Studies. Psychological Methods, (15): 250-267.

Stipanovic, N., Stringfield, S., & Witherell, E. (2017). The influence of a career pathways model and career counseling on students' career and academic self-efficacy. Peabody Journal of Education, 92(2), 209-221.

West, M., & Vosloo, S. E. (2013). UNESCO policy guidelines for mobile learning. Paris: UNESCO.

Williamson, B. (2017). Decoding ClassDojo: Psycho-policy, social-emotional learning and persuasive educational technologies. Learning, Media and Technology, 42(4), 440-453. doi:10.1080/17439884.2017.1278020.

Xiangming, L., & Song, S. (2018). Mobile technology affordance and its social implications: A case of "Rain classroom": Mobile technology affordance & social implications. British Journal of Educational Technology, 49(2), 276-291. doi:10.1111/bjet.12586.