Can a smartphone application measure driving behavior during the learner permit period?

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Abstract

Introduction: The purpose of this study was to measure the effect of the logbook format (i.e., paper vs. a smartphone application [app]) on self-reported learner driving behavior. For those who used the app (the electronic logbook), we compared the agreement between their survey-reported trips and the trips recorded by the app and asked about their perceptions of using an app to measure driving.

Methods: Data were collected for 147 parent-teen dyads (pairs) in the electronic logbook group and 131 parent-teen dyads in the paper logbook group for 6 continuous months while teenagers held a learner permit to practice driving under the supervision of a licensed driver. Self-reported driving was collected using six consecutive monthly surveys where parents/guardians were asked to report the amount of driving completed by their teen during the past week. App-recorded trips for the same week were identified for each electronic logbook dyad and compared with their survey data.

Results: On average, participants reported driving 2.5 trips and 3.0 hours in the prior week, with a wide between-subjects range in practice driving. There were no statistically significant differences in any measures of self-reported practice driving (trips, hours, or variety) by logbook type (electronic vs. paper). Agreement between self-reported and app-recorded trips ranged from 68.6% to 79.0% of trips (allowing for a difference of two trips per week). User satisfaction with the electronic logbook was high, with 93.0% of teenagers and 91.9% of parents stating they would recommend the app to a friend. A slightly lower percentage of participants stated they would be willing to continue to use the app beyond the study period (89.5% of teenagers and 86.2% of parents). Almost half of teenagers (42.1%) and one third of parents (30.1%) reported issues using the app at some point during the study, and a small percentage of participants stated the app was a burden (6.1% of teenagers and 4.9% of parents).

Conclusions: The findings demonstrate that the use of an electronic logbook is a viable approach to measuring practice driving during the learner stage of licensure. There was no difference in the self-reported amount of driving between the paper logbook and electronic logbook groups, suggesting that practice driving behavior was not impacted by the data collection method.

Keywords: logbook, teenage drivers, learner permit
1. **Introduction**

In most U.S. and Australian states, 16- and 17-year-olds who are learning to drive are required to complete a minimum amount of practice driving (typically 50 hours) under the supervision of a licensed driver (usually a parent) before they are eligible to take the driving test (Insurance Institute for Highway Safety, 2022). The rationale for this supervised driving requirement is that teenagers will develop skills that could provide a safety benefit during early independent driving, when their crash risk is highest (Curry et al., 2015).

Certain jurisdictions, such as Maryland and Virginia in the United States and New South Wales and Queensland in Australia, also require that supervised practice driving hours be recorded in a logbook, signed by a parent or guardian, and submitted to the licensing authority as evidence that practice was completed (Maryland Department of Transportation, 2020; Queensland Government, 2021; Transport for New South Wales, n.d.-b). For example, in Maryland learners and their driving supervisors are required to record the date, the start and end time, the skill or activity practiced, and a tally of the total hours of practice driving completed to date. Learners submit their logbook to the licensing agency prior to taking the practical driving test to obtain a driving license (Maryland Department of Transportation, 2020).

In addition to state-specific requirements for logbooks, a number of private companies have developed smartphone applications (apps) for teenagers to track the amount of practice driving, and several are endorsed by state-licensing agencies as an electronic alternative to a paper logbook (Shepard Center, n.d.; The Parent’s Supervised Driving Program, n.d.; Transport for New South Wales, n.d.-a). Over 95% of teenagers in the U.S. have access to a smartphone (Anderson & Jiang, 2018), and the advent of apps that record and verify supervised practice driving could offer a viable alternative to a paper logbook. These apps, also called electronic logbooks, may offer some benefits over paper logbooks, such as an automatic summary about each drive (distance and time driven), and an accumulated total of supervised practice driving hours, including the hours driven at night. The availability of summary data about driving may also encourage more practice to the extent that the learner driver is motivated to
achieve their driving goals or perceives the consequences from not doing so, akin to reaching a target number of steps on an activity tracker (Carver & Scheier, 1998).

Even though logbooks for learner drivers have been required by law in a number of jurisdictions for several years, surprisingly little is known about how they are used and whether the logbook format (paper vs. electronic) influences practice driving behavior. Prior research with parents from Queensland, Australia, found that paper logbooks provided a number of benefits, such as encouraging learner drivers to better structure their driving experiences (Bates et al., 2008). In another study in the same Australian state, some learner drivers indicated that they falsified paper logbooks by rounding up hours of practice driving and fabricating trips that were not taken (Scott-Parker et al., 2011). Paper logbooks could provide an inaccurate record of practice, potentially undermining their intended purpose and creating a system that is open to misuse (Bates et al., 2014).

To the best of our knowledge, no studies have compared the use of a paper logbook with an electronic logbook to measure supervised practice driving. The purpose of this study was to measure the effect of the logbook format (i.e., paper vs. an electronic smartphone app) on self-reported learner driving behavior. Furthermore, among those who used the electronic logbook, we compared the agreement between their survey-reported trips and trips recorded by the app (electronic-logbook-recorded trips) and asked about their perceptions of using an app to measure practice driving.

2. Materials and methods

2.1 Participants and selection criteria

This study required the participation of teenage drivers ages 15–19 and one of their parents or guardians, residing in Maryland, USA. All eligible teenagers expected to hold their learner permit for at least 6 months after their participation in the study began. Participant dyads (teenage driver and parent/guardian pairs) were required to speak English, have access to the Internet, and use a smartphone that was less than 4 years old with either the Android or iOS (Apple) operating system. Maryland requires drivers ages 25 or younger to practice a minimum of 60 hours under the supervision of a licensed adult
during the learner permit stage. Novice drivers ages 18 and younger are required to hold a learner permit for at least 9 months, and novices who are 19 years old are required to hold a learner permit for at least 3 months (Maryland Department of Transportation, 2020).

2.2 Study design

Participant dyads were assigned to the paper or electronic logbook group according to a block design, where dyads in the electronic logbook group, the intervention arm of the study, were enrolled first followed by the enrollment of dyads in the paper logbook group, the control arm. All participants were required to complete surveys at baseline (before the study began) and at 6 months. Parents/guardians also completed monthly surveys about the amount, consistency, and variety of supervised practice driving completed by their teenager.

Electronic logbook participants were required to use a custom-built app to measure their driving behavior for the duration of the study. This app measured trip length (using time stamps from the start and end of each trip), vehicle accelerations, and driving routes (using the smartphone’s global positioning system [GPS]). Participants assigned to use the paper logbook were instructed to complete the logbook as required by the state licensing agency. The Johns Hopkins School of Public Health Institutional Review Board approved the study (IRB# 8283).

2.3 Recruitment, consent, and compensation

Participant recruitment began in person in January 2020 at Motor Vehicle Administration (MVA) offices throughout Maryland. In March 2020, the Maryland MVA offices closed because of the COVID-19 pandemic, which prevented any further in-person recruitment. We moved our advertising and recruitment efforts online using the social media channels of Facebook and Instagram. While Maryland relaxed the requirements for the driving skills test during the pandemic, the state's learner permit requirements (described in Section 1, Introduction) remained unchanged.
During in-person screening at MVA offices, a team member described the study aims and eligibility criteria to potential participants. Upon determining eligibility, written consent was obtained from the parent/guardian, and with their permission, written consent was sought from the teenager.

During online screening, potential participants were directed to complete a screening form. After completing the form to determine eligibility, eligible parents/guardians and teenagers were invited to participate in a phone conversation where a team member briefly described the study aims, obtained verbal consent from the parent/guardian, and with parental permission, obtained verbal assent from the teenager.

Participants assigned to the electronic logbook group were informed that the study would involve collecting survey data alongside driving data from a smartphone app (including trip duration, driving routes via GPS, and vehicle acceleration and braking patterns). A team member provided participants with detailed instructions to download the app and explained how it works. To restrict use of the app to only the eligible study participants, a unique username and password were generated for each app user during enrollment. Logging into the app linked the smartphone to the participant’s study profile so that progress could be tracked over the duration of the study. Once logged in, the user remained logged in to streamline access and improve data collection. Paper logbook participants were informed that the study would involve collecting survey data.

Both intervention and control participants were incentivized for their participation in the study: we paid $150 to each electronic logbook dyad, and $40 to each paper logbook dyad. Further details about the features of the app and the study protocol are described in a prior publication (Ehsani et al., 2021).
2.4 Data collection

2.4.1 Survey data

Baseline survey: Multiple scales were administered to the parents/guardians and separately to the teenagers. Baseline survey instruments included personality scales (Hoyle et al., 2002) measures of the parent-teen relationship (Simons-Morton et al., 2013), teenagers’ risk-taking behavior and risky friends (Akers et al., 1979), prior driving experience (Ehsani, Li, et al., 2017), and parents’ perception of their teens’ readiness to drive independently (University of North Carolina Center for the Study of Young Drivers, 2018).

Monthly surveys: Parents/guardians were administered a monthly survey regarding the (a) amount of practice driving (trips and hours) in the past week; and (b) variety of practice driving completed by their teenager in the past month. These were measured on each of the monthly surveys, as follows:

- **Number of trips.** Respondents indicated the number of trips they took with their teenager in the past week for the purpose of supervised practice driving.
- **Number of hours driven.** Respondents indicated the number of hours their teen drove in the past week.
- **Practice variety.** Respondents indicated the amount of supervised practice driving completed in the past month in each of the following six environments:
  1. Empty parking lots
  2. Residential neighborhoods
  3. One- or two-lane intermediate roads
  4. Rural roads
  5. Commercial roads
  6. Highways

  The amount of driving in each environment was measured on a 5-point scale, where
  1 = None,
  2 = Less than 1 hour,
  3 = 1 to 2 hours,
  4 = 3 to 5 hours, and
  5 = More than 5 hours.

  Practice driving variety was defined as the number of environments where any amount of practice was reported.
Six-month survey: At the 6-month follow-up survey, parents/guardians and teenagers who were assigned to the electronic logbook group were asked about their perceptions of the app. Participants were asked (1) if they would recommend the app to a friend, a measure of user satisfaction developed by Reichheld (2006); (2) if they would be willing to use the app beyond the study period; (3) if they experienced issues with the app; and (4) if using the app was burdensome in any way.

2.4.2 Smartphone trip data

For each trip, participants using the electronic logbook were required to open the app at the beginning of the trip; press "Start" to begin data collection; and then at the end of the trip, press "Stop" to end data collection. Following the trip, the app presented summary information including the trip length and duration. Electronic logbook users could indicate the road types they encountered during their drive (the six environments listed in Section 2.4.1, Survey data) and the weather conditions (wet, dry). App users could view a summary of their practice driving data on a separate screen indicating the number of trips completed on each day of the week, total mileage, total hours, and total drives. To minimize the possibility of invalid trip data collection, such as inadvertently starting a trip or forgetting to end a trip, a valid trip was defined as having a distance of greater than 0 miles and a duration of between 2 minutes and 120 minutes.

2.5 Data analysis

We compared the electronic and paper logbook participants on demographic and driving characteristics at baseline using Chi-squared tests and Fisher’s exact tests for categorical variable comparisons and $t$ tests and Mann-Whitney U tests for continuous variable comparisons. Mixed effects models were used to account for repeated individual measures across follow-up surveys. Negative binomial regression models with random intercepts for each respondent were used to model number of trips and practice variety. A linear regression model with random intercepts was used to model number of hours driven. All models included logbook type (electronic vs. paper) and time point (five indicator
variables representing follow-up months 2 to 6 vs. month 1), and an interaction term between study group and time point.

All models adjusted for days between the learner permit date and study start date, the teenager’s prior driving experience, and the parent’s perception of their teenager’s readiness to drive at baseline, all standardized (i.e., rescaled to have a mean of zero and a standard deviation of 1). Additional models with three-way interactions were explored: prior driving experience or readiness to drive at baseline, study arm (intervention or control), and time point. Interaction terms not significant at the 0.05 level were dropped from the final model. All analyses were carried out using the R programming language, version 4.0.2.

2.6 Sensitivity analysis

When responding to monthly survey questions about the amount of practice driving, some parents/guardians indicated zero number of trips taken but a non-zero number of hours driven (8.2% of all responses). In such cases where the number of trips was indicated to be zero, the number of hours driven was also set to zero. In addition, one parent reported 98 practice driving trips taken in a week at the 2-month follow-up time point. This observation was excluded as an outlier in the main analysis. Sensitivity analyses showed that neither adjusting the number of hours driven nor including the outlier changed the pattern of results.

2.7 Agreement between self-reported and electronic-logbook-recorded driving

Self-reported driving was collected during monthly surveys where parents/guardians were asked to report the amount of driving completed by their teen during the past week. Electronic-logbook-recorded trips for the same week were identified for each participant using the electronic logbook. The Bland-Altman method comparison approach was used to assess agreement between the two logbook types, using the difference between self-reported and electronic-logbook-recorded trips as a measure of agreement between these two measurements, 95% confidence intervals for the difference (i.e., limits of agreement), and 95% confidence intervals for the upper and lower limits of agreement (Bland & Altman, 1986), while accounting for repeated measures (Bland & Altman, 2007). This method also estimates from
an observed measurement by one method what the value of a measurement on the same person at the 
same time by the other method might be (Bland & Altman, 1999). If the limits of agreement are 
sufficiently narrow to draw the same conclusions about driving regardless of the source of measurement, 
we can conclude the two measurements agree sufficiently to be used interchangeably.

The Bland-Altman measurement comparison analyses was performed for trips that were (a) 
defined as longer than 2 minutes and greater than 0 miles, to eliminate the possibility of including trips 
that were inadvertently recorded due to user error; and (b) longer than 120 minutes, to eliminate the 
possibility of including trips where users failed to stop recording a drive when it had ended. We excluded 
from the analyses 23 teens who did not have any trips recorded by the electronic logbook for the 6-month 
study period.
3. Results

3.1 Sample characteristics

A total of 917 individuals responded to in-person and online recruitment efforts, of which 337 dyads fulfilled the eligibility criteria and were enrolled in the study. Of these, 186 dyads were assigned to the electronic logbook group and 151 dyads were assigned to the paper logbook group.

Participants were considered to have complete data if the parent and teenager completed at least the baseline survey and one monthly survey at the designated time point. In the electronic logbook group, 181 dyads had complete baseline data, and 177 dyads had at least one monthly follow-up complete. In the paper logbook group, 142 dyads had completed the baseline survey, and 137 dyads had at least one monthly follow-up complete. To limit differences due to geographic location, we excluded 32 participant dyads who were enrolled in the study but resided outside of the state of Maryland. Four dyads were removed from the analysis due to data entry errors (3 dyads) or missing data (1 dyad) on surveys.

The final sample was 147 dyads in the electronic logbook group and 131 dyads in the paper logbook group. Table 1 presents the baseline characteristics between the electronic and paper logbook participants. The individual characteristics of the teenagers and parents in the electronic logbook and paper logbook samples were not significantly different from one another. Teenagers using the paper logbook reported more pre-permit driving experience and had also held a learner permit longer than the electronic logbook group when they enrolled in the study. Table 2 presents the number of participants in the electronic and paper logbook groups that completed the surveys each month.
3.2 Practice driving trips, hours, and variety

Across the entire sample, on average participants reported driving 2.5 trips and 3.0 hours in the past week. There was a wide between-subjects range in practice driving, as shown by the standard deviation lines in Figure 1. There was no change in the average number of hours of practice driving across the 6-month study period. Relative to month 1, the average number of trips decreased in months 3 and 4 (ratio = 0.87, 95% confidence interval [CI] [0.76–1.00], \( p = 0.05 \); ratio = 0.83, 95% CI [0.72–0.96], \( p = 0.01 \) respectively). Practice variety significantly increased in month 6 compared with month 1 (ratio = 1.12, 95% CI [1.02–1.22], \( p = 0.02 \)).

3.3 Differences in self-reported practice driving by electronic versus paper logbook

Averaged across the 6-month study period, there were no statistically significant differences in any measures of self-reported practice driving (trips, hours, or variety) by logbook type (electronic vs. paper) (Figure 1). Table 3 presents the estimates of the mixed effects model for hours, trips, and practice variety.

In the first month of the study, the electronic logbook users reported more trips relative to the control arm and the difference was significant (ratio = 1.26 trips, 95% CI [1.00, 1.60], \( p \) value = 0.05). Otherwise, the amount of self-reported practice driving was not significantly different by logbook type for the remainder of the months.

3.4 Agreement between self-reported and electronic-logbook-recorded driving

Across the 6 months of the study, there was perfect agreement (i.e., no difference) between self-reported and electronic-logbook-recorded trips for an average of 30.7% of trips, ranging between 28.4 and 33.0% of trips (Figure 2a). When the agreement threshold included an absolute value difference of two trips (e.g., a survey report of six trips and an electronic logbook record of four or eight trips), the agreement was for 72.5% of the sample. Across the 6 months, this ranged between 68.6% and 79.0% of the sample. These analyses excluded the 23 teens from the electronic logbook group who recorded no practice driving trips during the study period.
The results indicate that participants consistently reported a higher number of trips in the previous week than the app recorded (mean discrepancy of 0.99 trips). In Figure 2b, the orange line shows the mean of all paired differences. The green lines represent the limits of agreement, which form the interval in which 95% of differences will fall. The dashed blue lines represent the 95% CIs of the limits of agreements. The calculated limits of agreement for the number of trips were $-3.81$ (95% CI: $-4.83$, $-2.88$) for the lower bound and $5.79$ (95% CI: $5.01$, $6.47$) for the upper bound, indicating that the majority of discrepancies were from four fewer self-reported trips to six more self-reported trips compared with the app-recorded trips. Taking the log transformation did not change the dependence of variance on the difference. The same patterns were observed for hours of practice and practice driving variety (data not shown).

3.5 Perceptions of the electronic logbook

User satisfaction of the electronic logbook was high, with 93.0% of teenagers and 91.9% of parents stating they would recommend the app to a friend. A slightly lower percentage of participants stated they would be willing to continue to use the app beyond the study period (89.5% of teenagers and 86.2% of parents). Almost half of teenagers (42.1%) and one third of parents (30.1%) reported issues using the app, and a small percentage of participants stated the app was a burden (6.1% of teenagers and 4.9% of parents).
4. Discussion

Learner driving logbooks are required in several jurisdictions to record practice driving during the learner stage and catalog driving under different conditions (Maryland Department of Transportation, 2020; Queensland Government, 2021; Transport for New South Wales, n.d.-b). The purpose of this study was to measure the effect of the logbook format (i.e., paper vs. electronic smartphone app) on self-reported supervised practice driving behavior. Further, among those who used an electronic logbook, we compared the agreement between their survey-reported trips and electronic-logbook-recorded trips and asked about their perceptions of using the app.

Using monthly self-reported surveys administered during the 6-month study period, we compared the practice driving behavior of the paper and electronic logbook groups and found no overall difference in the amount of trips, hours, and practice variety between the logbook types. Consistent with a number of previous studies, we found that practice driving was highly variable during the learner period across the entire sample (Ehsani, Klauer, et al., 2017). However, we did find in the first month of the study that the electronic logbook users reported more trips relative to the control arm. This short-term effect on driving behavior may have been related to the novelty of the app.

Among those using the electronic logbook, the number of self-reported trips was higher than the electronic-logbook-recorded trips by approximately one trip in a given week. However, the 95% CI for the differences were wide, ranging between four fewer trips to six more self-reported trips. This suggests that the self-reported and app-recorded trip measures should not be used interchangeably. While self-report driving measures are known to be affected by recall bias (Staplin et al., 2008), further research is needed to establish whether the electronic logbook could be considered as the more accurate "gold standard" measure.

Although approximately one third of participants experienced problems with the app at some point during the study, an overwhelming majority of both parents/guardians and teenagers stated they would recommend the electronic logbook to a friend and stated they would be willing to continue using
the app beyond the study period. It is not possible to state whether these usability perceptions are specific
to the app used in this study or would be more widely generalizable to all electronic logbooks that
measure practice driving. Nevertheless, these findings are encouraging and suggest that electronic
logbooks may enjoy high levels of user acceptance, even if problems are encountered during their use.

4.1 Strengths, limitations, and future work

This study used intensive survey- and smartphone-based measures from a sample of parent-teen
dyads, to prospectively collect data on learner driving behavior for 6 continuous months. Despite some
attrition, the final study sample represents one of the largest studies of learner drivers’ behavior in the
United States. The survey data for all participants, combined with the app-recorded data from the sample
of participants using the electronic logbook, provides an unprecedented and rich source of information
about early driving behavior.

As recruitment for this study occurred during the first months of the COVID-19 pandemic, we
had to relax the inclusion criteria when in-person enrollment was moved online. During in-person
enrollment at the Maryland MVA, participants were enrolled on the day they received a learner permit.
After recruitment shifted online, we could no longer verify teen participants’ time from permit but
required that participants drive with a learner permit for a minimum of 6 months. While this eliminated
the possibility of measuring driving behavior from the same time point for each participant, prior studies
have shown that practice driving often occurs before the permit period begins (Ehsani, Li, et al., 2017)
and that the amount of practice driving during the learner driving period is relatively stable (Ehsani,

Direct comparison between electronic and paper logbook groups was done using self-report
survey data. While the self-reported driving behavior of the participants using the electronic logbook
could be compared with the trips recorded by the app, the paper logbook participants’ driving behavior
could not be verified by other means. The electronic logbook participants were required to engage with
the app at the beginning and end of each drive, while control group participants recorded their drives in
their paper logbooks at their convenience; this introduces the possibility that the app users’ required and regular engagement with their practice driving could have altered their behavior. The temporary increase in the number of trips among electronic logbook users during the first month of the study may suggest that an interactive, engaging app may be effective in altering practice driving during the learner period.

Electronic logbooks that can verify the amount of practice driving completed during the learner stage of graduated driver licensing offers a step towards a performance-based licensing system (Ehsani et al., 2022). This approach would make progression to the on-road skills test and independent licensure contingent on completing the required number of practice driving hours, based on objective behavioral data. This may encourage more practice driving by preventing learner drivers from falsifying their logbooks in states where logbooks are required and creating an expectation that the required number of supervised practice hours are mandatory for progression through the licensing system. The feasibility of using this approach could be established in a demonstration project in a single state, which would determine large-scale feasibility and user acceptance, including logistical aspects and understanding any implications for equity.

5. Conclusion

The findings of this study demonstrate that the use of an electronic logbook is a viable approach to measuring practice driving during the learner stage of licensure. Except during the first month of data collection, there was no difference in the self-reported amount of driving between the paper logbook and electronic logbook participants, suggesting that practice driving behavior is not impacted by the data collection method. The majority of study participants using the electronic logbook reported high levels of satisfaction and were willing to continue using the app beyond the study period, despite encountering some challenges.
### Table 1. Sample characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Electronic logbook (N=147)</th>
<th>Paper logbook (N=131)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual-level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teenager age, mean (SD)</td>
<td>16.3 (0.5)</td>
<td>16.4 (0.6)</td>
<td>0.587</td>
</tr>
<tr>
<td>Teenager sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>90 (61.2%)</td>
<td>74 (56.5%)</td>
<td>0.596</td>
</tr>
<tr>
<td>Male</td>
<td>55 (37.4%)</td>
<td>56 (42.7%)</td>
<td></td>
</tr>
<tr>
<td>Prefer not to answer</td>
<td>2 (1.4%)</td>
<td>1 (0.8%)</td>
<td></td>
</tr>
<tr>
<td>Teenager race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>8 (5.4%)</td>
<td>4 (3.1%)</td>
<td>0.109</td>
</tr>
<tr>
<td>Black or African American</td>
<td>17 (11.6%)</td>
<td>6 (4.6%)</td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td>14 (9.5%)</td>
<td>14 (10.7%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 (0.7%)</td>
<td>4 (3.1%)</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>107 (72.8%)</td>
<td>103 (78.6%)</td>
<td></td>
</tr>
<tr>
<td>Parent age, mean (SD)</td>
<td>48.0 (4.8)</td>
<td>48.0 (4.5)</td>
<td>0.942</td>
</tr>
<tr>
<td>Parent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>127 (87.0%)</td>
<td>110 (84.0%)</td>
<td>0.588</td>
</tr>
<tr>
<td>Father</td>
<td>19 (13.0%)</td>
<td>21 (16.0%)</td>
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</tr>
<tr>
<td>Parent race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>8 (5.5%)</td>
<td>3 (2.3%)</td>
<td>0.100</td>
</tr>
<tr>
<td>Black or African American</td>
<td>16 (11.0%)</td>
<td>5 (3.8%)</td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td>2 (1.4%)</td>
<td>2 (1.5%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2 (1.4%)</td>
<td>2 (1.5%)</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>118 (80.8%)</td>
<td>118 (90.8%)</td>
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</tr>
<tr>
<td><strong>Household-level</strong></td>
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<td></td>
</tr>
<tr>
<td>Residence</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>145 (98.6%)</td>
<td>127 (96.9%)</td>
<td>0.425</td>
</tr>
<tr>
<td>Rural</td>
<td>2 (1.4%)</td>
<td>4 (3.1%)</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below $80,000</td>
<td>21 (14.3%)</td>
<td>10 (7.6%)</td>
<td>0.117</td>
</tr>
<tr>
<td>$80,000 or above</td>
<td>126 (85.7%)</td>
<td>121 (92.4%)</td>
<td></td>
</tr>
<tr>
<td>Teen driving experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior driving experience (teen reported), median [IQR]</td>
<td>5 [2, 11]</td>
<td>8 [5, 12]</td>
<td>0.030</td>
</tr>
<tr>
<td>Days from permit date to study start date, median [IQR]</td>
<td>34 [15, 55]</td>
<td>50 [23, 71.5]</td>
<td>0.005</td>
</tr>
<tr>
<td>Scores from baseline surveys</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensation-seeking score (teen reported) (SD)</td>
<td>22.4 (5.3)</td>
<td>22.1 (5.4)</td>
<td>0.612</td>
</tr>
<tr>
<td>Parent knowledge of teen activities/friends score (parent reported), median [IQR]</td>
<td>35 [32, 37]</td>
<td>35 [33, 37]</td>
<td>0.609</td>
</tr>
<tr>
<td>Parent knowledge of teen activities/friends score (teen reported), median [IQR]</td>
<td>34 [31, 36]</td>
<td>35 [31, 36]</td>
<td>0.752</td>
</tr>
<tr>
<td>Teen’s risky friends score (parent reported), median [IQR]</td>
<td>21 [17, 26]</td>
<td>21 [17.5, 26]</td>
<td>0.786</td>
</tr>
<tr>
<td>Teen’s risky friends score (teen reported), median [IQR]</td>
<td>19 [16, 22]</td>
<td>18 [16, 23]</td>
<td>0.678</td>
</tr>
</tbody>
</table>

Note. IQR = interquartile range. SD = standard deviation.
Table 2. Number of participants that completed the follow-up surveys, by month number and logbook type

<table>
<thead>
<tr>
<th>Follow-up month</th>
<th>Electronic logbook N = 147 at baseline</th>
<th>Paper logbook N = 131 at baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>124 (84.4%)</td>
<td>114 (87.0%)</td>
</tr>
<tr>
<td>2</td>
<td>114 (77.6%)</td>
<td>114 (87.0%)</td>
</tr>
<tr>
<td>3</td>
<td>100 (68.0%)</td>
<td>103 (78.6%)</td>
</tr>
<tr>
<td>4</td>
<td>97 (66.0%)</td>
<td>90 (68.7%)</td>
</tr>
<tr>
<td>5</td>
<td>91 (61.9%)</td>
<td>86 (65.6%)</td>
</tr>
<tr>
<td>6</td>
<td>124 (84.4%)</td>
<td>111 (84.7%)</td>
</tr>
</tbody>
</table>

Table 3. Mixed effects model comparing self-reported practice driving between electronic and paper logbook participants

<table>
<thead>
<tr>
<th>Follow-up month</th>
<th>Self-reported practice driving trips</th>
<th>Self-reported practice driving hours</th>
<th>Self-reported driving variety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Electronic–paper logbook (95% CI)</td>
<td>Electronic–paper logbook (95% CI)</td>
<td>Electronic–paper logbook (95% CI)</td>
</tr>
<tr>
<td>1</td>
<td>1.26 * (1.00, 1.60)</td>
<td>0.42 (−0.35, 1.25)</td>
<td>1.02 (0.89, 1.16)</td>
</tr>
<tr>
<td>2</td>
<td>1.09 (0.86, 1.38)</td>
<td>0.40 (−0.51, 1.34)</td>
<td>1.06 (0.92, 1.21)</td>
</tr>
<tr>
<td>3</td>
<td>1.07 (0.83, 1.38)</td>
<td>−0.30 (−1.21, 0.70)</td>
<td>0.95 (0.83, 1.10)</td>
</tr>
<tr>
<td>4</td>
<td>1.01 (0.78, 1.32)</td>
<td>0.45 (−0.53, 1.72)</td>
<td>0.97 (0.83, 1.12)</td>
</tr>
<tr>
<td>5</td>
<td>1.02 (0.78, 1.33)</td>
<td>−0.12 (−0.95, 0.74)</td>
<td>1.09 (0.93, 1.27)</td>
</tr>
<tr>
<td>6</td>
<td>0.82 (0.65, 1.05)</td>
<td>−0.98 (−1.94, −0.03)</td>
<td>1.00 (0.88, 1.14)</td>
</tr>
</tbody>
</table>

*Note*. CI = confidence interval.

* Indicates a significantly higher number of self-reported trips in the electronic logbook group.
7. Figures

Figure 1
Number of self-reported trips and hours driven and practice variety in the paper versus electronic logbook groups by month (N=278)

Continued on next page.
**Figure 1** (continued)

Practice variety in the paper versus electronic logbook groups by month (N=278)

Note. For each follow-up month, the circles are the mean number of trips and the lines represent one standard deviation.
Figure 2a
Agreement between self-reported and electronic-logbook-recorded trips (N=124)

Note. Percentages describe the agreement between the number of trips (± two trips). Excluded from the analysis were 23 teens from the electronic logbook group who recorded no practice driving trips during the study period.
Figure 2b
Bland-Altman plot of self-reported and app-recorded trips for electronic logbook users
8. References


Shepard Center. (n.d.). *Safe driver training app for parents of teens: AutoCoach 2.0* [web page]. https://www.shepherd.org/about/injuryprevention/autocoach


