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Electronic Flight Bag Policies at Collegiate Aviation Programs

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Electronic flight bags (EFBs) are now commonplace among air carriers throughout the world. In the United States, the FAA requires air carriers to implement EFB policies and training. University aviation programs should consider EFB policies to better prepare professional pilots for their careers. This study investigated flight school EFB practices at collegiate aviation programs, and whether an official EFB policy had any effect upon EFB practices as they related to FAA guidance. Results indicated that the presence of an EFB policy at a flight school does not guarantee conformity to FAA guidance. In some areas, EFB practices at programs without policies better conformed to FAA guidance.

Literature Review

The FAA encourages certain EFB practices for Part 91 operations in Advisory Circular 91.78. Although not regulatory in nature, it states that the electronic charts should be the functional equivalent of the paper reference material, current, up-to-date, and valid, that pilots should be trained on where to stow the EFB for takeoff and landing, and the legends for all charts should be available (FAA, 2007, p. 3). Stowage of the EFB when it is not in use can be an issue, as the tablets can cause inadvertent activation of flight controls or overheat if left in direct sunlight in the cockpit (Chase & Hiltunen, 2014).

Additional guidance on EFB practices has also been developed by the FAA Human Factors Division. In 2014, members of the Human Factors Division investigated 276 safety reports which considered EFBs as either a contributing factor to safety or possibly a contributing factor to safety in the future. The reports were collected from seven different aviation/transportation agencies across the globe. The reports were either required or voluntary and included both recreational and commercial flight operations. The reports created concerns about backup chart considerations, electromagnetic interference considerations for the magnetic compass, increasing EFB training quality by air carriers, currency of EFB data, hardware failure and failure modes, storage of the EFB when not in use, software errors and failure modes, and the potential of distraction related to EFBs. The reports included airline pilots, and researchers noted a lack of training or insufficient EFB training at air carriers (Chase & Hiltunen, 2014).

Collegiate aviation programs commonly implement new technologies and/or training to better align practices with air carrier operations. This includes training in Crew Resource Management (CRM), Safety Management Systems (SMS), and the utilization of transport-category flight training devices. Crew Resource Management (CRM) training has been practiced and researched for decades, and today CRM principles have been taught in the classroom for years

(Velasquez & Bier, 2015). CRM has also been implemented in primary flight training despite its constant evolution. In 2002, a study generated guidelines for implementing CRM in the first stages of flight training (Turney, 2002).

The FAA's Advisory Circular 120.92A requires Safety Management Systems for air carriers. As for flight programs, to receive accreditation from the Aviation Accreditation Board International (AABI), collegiate programs must develop and use SMS (AABI, 2013). Many collegiate aviation programs are implementing SMS, even though SMS education is still "limited in undergraduate AABI-accredited programs" (Velasquez & Bier, 2015, p. 10). Other researchers have provided guidance to collegiate programs on how to successfully implement an SMS program during a four-year implementation period (Adjekum, 2014). Similar implementation plans could be developed for EFB practices.

A study at the University of Central Missouri investigated the effective use of a transport-category FTD for flight training purposes in 2012. The research was performed in response to concerns over graduating pilots' preparation for initial training with an air carrier. Ultimately, the researchers chose to use a Boeing 737NG with the latest avionics in order to "bridge the experience gap between college and the professional environment" (Preudhomme, Lu, & Martinez, 2012, p. 6). Electronic flight bags should be considered as onboard systems and should be treated similarly to new avionics.

EFB guidelines should also be considered by collegiate aviation programs, as this technology and the associated practices can impact flight safety. Furthermore, flight school EFB practices can be easily established by emulating practices established by air carriers. Air carriers must develop EFB policies and training per the requirements in Advisory Circular 120.76C. This advisory circular provides more guidance than AC 91.78, and is regulatory in nature. Associated guidelines in AC 120.76C include, but are not limited to establishment of a training program including EFB failure mode training, stowage of the EFB when not in use, battery charge dispatch requirements and in-flight charging considerations, and the carriage of paper backup charts during a six-month EFB trial period (FAA, 2014). A recent study revealed that only 50% of active Part 121 pilots believed that the initial EFB training provided by their airline was adequate (Lytle, 2015). A flight student may benefit from an exposure to EFB policies prior to their air carrier experience, as they must adhere to established EFB policies once hired by an air carrier.

Air carriers are required to establish minimum battery charge for dispatch per the requirements of Advisory Circular 120.76A. The advisory circular states

that the operator must comply with one of the following three requirements: (1) establish a procedure to recharge the battery during flight, (2) the battery or batteries must have a combined useful life to ensure operation during taxi and flight operations including diversions and expected delays, or (3) an acceptable mitigation strategy to retrieve information by other means (FAA, 2014). Some airline pilots are discouraged with the battery life of their EFBs, stating that a full duty day does not allow them to view manuals in flight (Lytle, 2015). As for Part 91 operations, Advisory Circular 91.76 has no specific requirement for battery charge, but does suggest a backup source of aeronautical information (FAA, 2007). Although flight schools are not required to comply with either requirement, a policy requiring a certain charge based upon flight time would best comply with these recommendations.

A common EFB software/hardware combination is the ForeFlight Mobile application on an Apple iPad, and this application has been found to be the most user-friendly by ab-initio pilots when compared to its competitors (Schwartzentruber, 2017). The software developer has even established an Educational Licensing Program (ELP) for collegiate programs which allow administrators to share flight school information via the application (ForeFlight, n.d.). According to ForeFlight, their software uses approximately 10-20% of an iPad battery per hour of operation, depending upon screen brightness, operation modes, and background applications (ForeFlight, 2017). EFB screen brightness is typically maximized for day operations, as screen glare has been a reported issue with EFB use (Chase & Hiltunen, 2014). Unfortunately, a default download of the application does not include chart legends. The pilot must actively download the legends within the application when using ForeFlight on an iPad (ForeFlight, n.d.)

Method

This research gathered qualitative and quantitative data from instructors and faculty at collegiate aviation programs. Contact information for the 85 qualified schools was gathered and emails were sent to recruit participants. The survey was administered via Survey Monkey and data was gathered in the Spring of 2017. Participation was completely voluntary. The study was authorized by the Middle Tennessee State Institutional Review Board and the protocol number was 17-1183.

Questions for the survey were generated to identify participants' type of position, determine the amount of conformity for hardware and software at each flight school, and determine EFB practices based upon FAA Advisory Circulars 91.78 and 120.76C. The survey consisted of 26 to 28 questions, depending upon participant responses. After a series of demographic questions including identifying

which school the participant was associated with, the survey asked if the program had an EFB policy and/or guidelines. At that point, though many questions remained the same, the wording of the questions changed. For example, instead of “Does your flight school encourage a hardware (tablet)?” the alternate question was “Does your flight school’s EFB policy encourage or required a hardware (tablet)?”

Participants

Participants were required to be at least 18 years old and consent to the survey. Participants included chief flight instructors, assistant chief flight instructors, flight instructors, and faculty members at AABI accredited universities and/or members of the University Aviation Association (UAA). A total of 77 total responses were gathered but nine were incomplete and thus removed. There were 68 usable responses which represented twenty different programs, yielding a program participation rate of 23%.

Results

Responses indicated widespread EFB use at all levels of flight training, including private pilot training and during the private pilot check ride. Though most participants indicated that their flight program had implemented an EFB policy (60%), there were several areas in which programs without EFB policies had better EFB practices, including requiring students to download legends, EFB training in the four areas as recommended by AC 91.78, requiring students to carry backup charts, and training students on how to stow the EFB when it was not in use.

Participants were asked if their flight school has implemented an EFB policy and/or guidelines. Most participants (60%) indicated that their flight school had some policy and/or guidelines. This information was then used to differentiate responses to subsequent questions.

The hardware/software combinations associated with the results was nearly uniform. The Apple iPad was used by all but one participant, and ForeFlight Mobile software was used by 94% of participants. An EFB policy had minimal effect upon hardware/software uniformity, but those respondents claiming an EFB policy all used ForeFlight Mobile, while three of the respondents without a policy (12%) used a different software.

The first survey question identified the type of position for each participant and how long that person had held that position. The 68 total participants included 38 flight instructors, 3 assistant chief flight instructors, 5 chief flight instructors,

and 22 faculty members. The next survey question identified participants' amount of experience in their positions, which may have had an impact upon their knowledge of flight school EFB practices and/or policies. Most participants (44 out of 68) had been working in their positions for at least one year. This information is summarized in Figure 1.

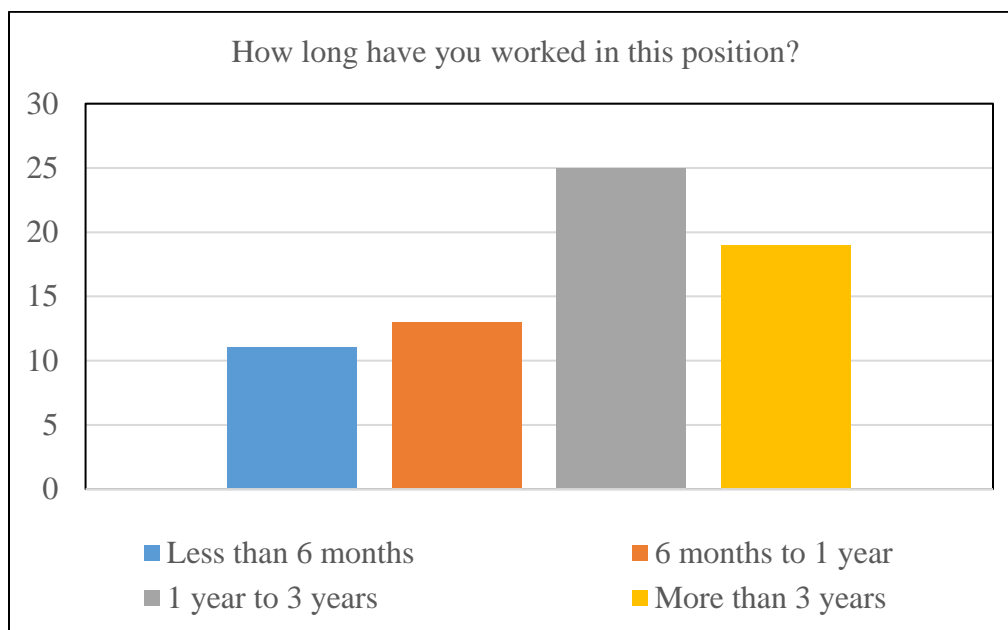


Figure 1. Duration of Employment in Positions for Survey Participants.

The next question identified the participant's associated collegiate aviation program. This data was gathered to ensure a suitable data set. Participants were ensured that the names of their respective institutions would not be reported. There were six programs that had at least three participants. The program with the most participants had 17 complete survey responses, and the second largest participation from one program included 10 responses.

Most participants (84%) agreed or strongly agreed that most pilots at their flight school used EFBs for flight training, and that included using EFBs for initial (private pilot) flight training at nearly half of the associated programs. However, many of the responses (54%) indicated that the students had to wait until instrument training to use EFBs. These results are summarized in Figure 2 and Figure 3.

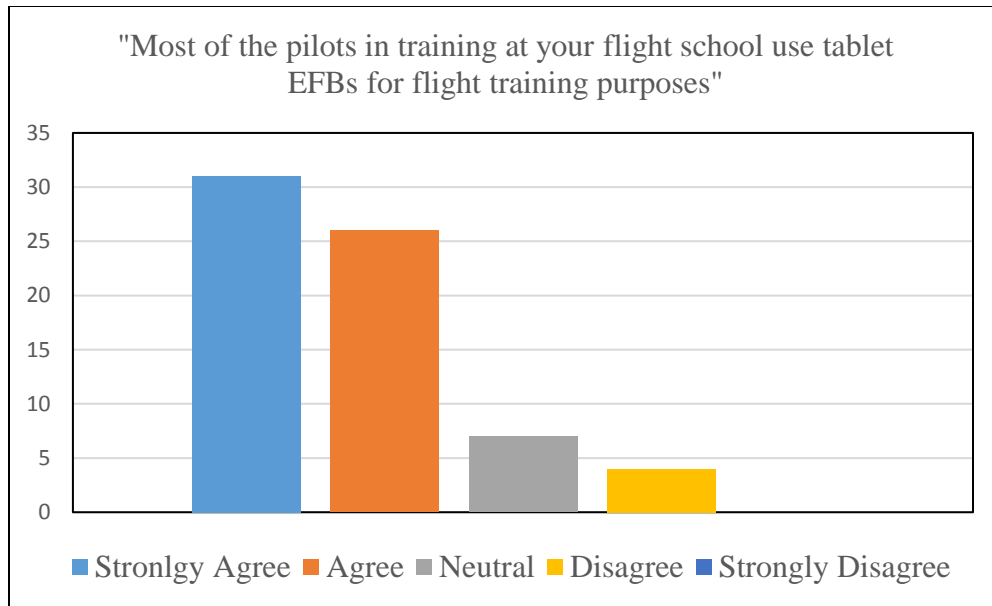


Figure 2. Participant's Perception of the Prevalence of EFB Use at Their Flight School.

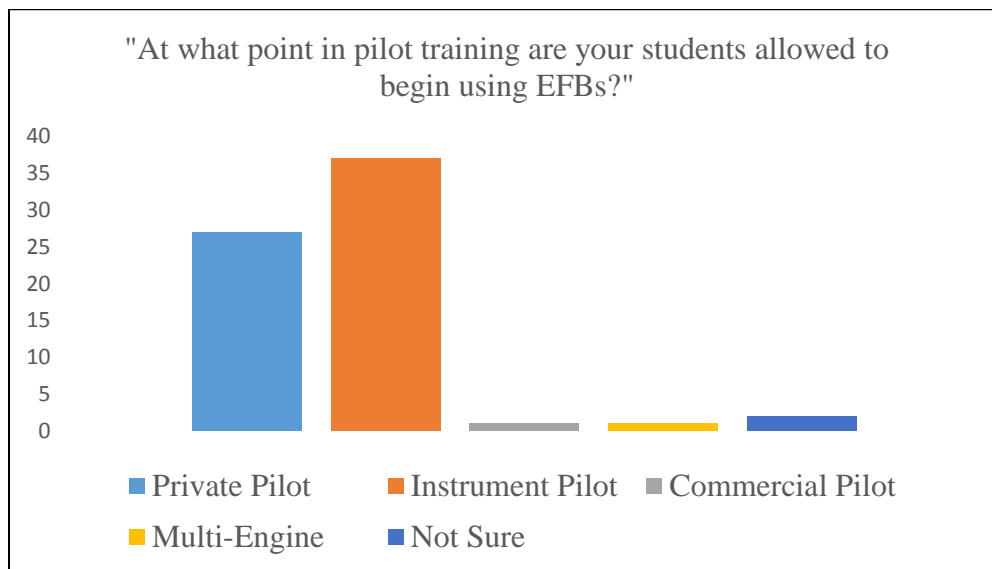


Figure 3. Types of Flight Training Allowing EFB Use for Each Participant's Flight School

The subsequent survey question pertained to private pilot flight training and VFR flight planning. Software such as ForeFlight mobile replaces conventional flight planning tools such as a sectional chart and E6B flight computer. This question gathered qualitative data based upon participants' opinions related to flight planning with EFBs as opposed to flight planning with conventional VFR flight planning materials. Most participants (66%), disagreed or strongly disagreed that EFBs should replace conventional VFR flight planning tools during private training. These responses represented all four job positions, including 68% of flight instructors, 33% of assistant chief flight instructors, 80% of chief flight instructors, and 64% of faculty members. The results are summarized in Figure 4.

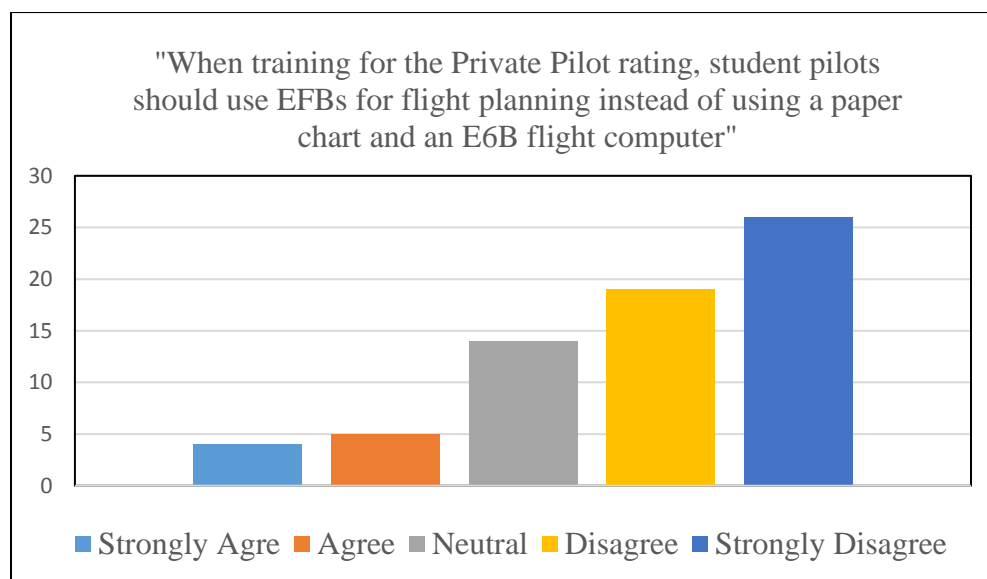


Figure 4. Participants' Opinions on VFR Flight Planning with EFBs as Opposed to Conventional Methods

Common EFB software typically include a navigation panel displaying relevant navigation data, including magnetic heading, ground speed, estimated time enroute, and fuel burn. However, VFR navigation logs as suggested by the FAA require pilots to document more details, including true course, wind correction angle, and magnetic variation (FAA, 2015). The next survey question asked participants if, during private or commercial training, their students were required to complete a paper navigation log including these components. Responses overwhelmingly replied "yes" (96%). Despite widespread use of EFBs at these

programs, hand-written navigation logs are still commonplace. Compatibility between the EFB and the navigation log used by the flight school may be an issue, depending upon the navigation information displayed on the software.

During private pilot check rides, EFB use by applicants may be highly varied, and Designated Pilot Examiners (DPEs) may or may not allow private applicants to use an EFB for the private pilot check ride. Based upon their personal experience, participants were asked if most pilot examiners allowed students to use EFBs on private pilot check rides. More than half of the participants (52%) responded “yes”, 13% responded “no”, and 35% responded “not sure”. Of the 24 participants which replied “not sure”, 15 were flight instructors, one was a chief flight instructor, and eight were faculty members.

In the flight training environment, it is logical that chart legends would be useful to students and instructors. Advisory Circular 91.78 states that legends should be available on the EFB. Participants were asked if their policy requires all pilots to download legends. As for participants at programs without policies, they were asked if they required students to download legends. Surprisingly, participants from flight schools without EFB policies were more insistent on downloading chart legends than policies at flight schools with EFB policies. The results are shown in Figure 5 and Figure 6.

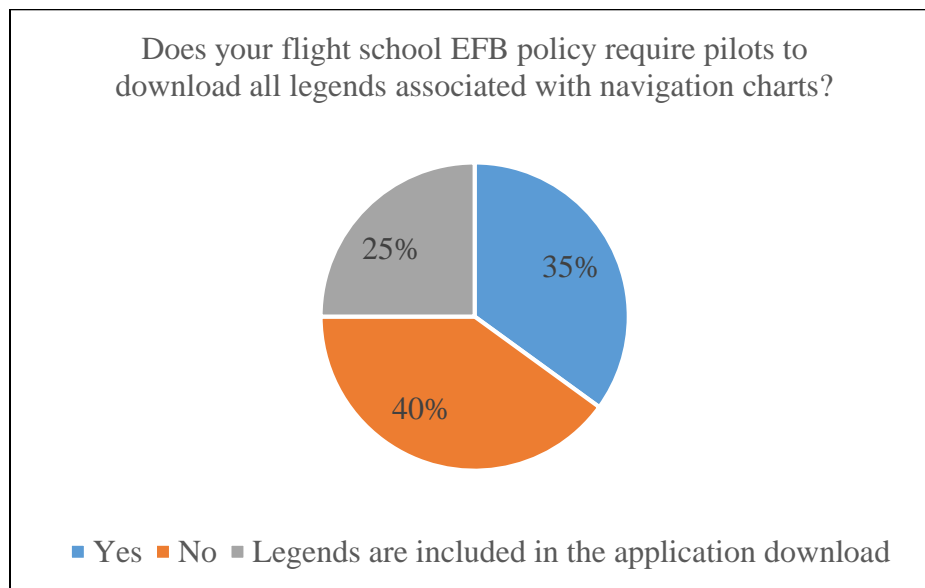


Figure 5. Required Chart Legend Downloads at Flight Schools with EFB Policies.

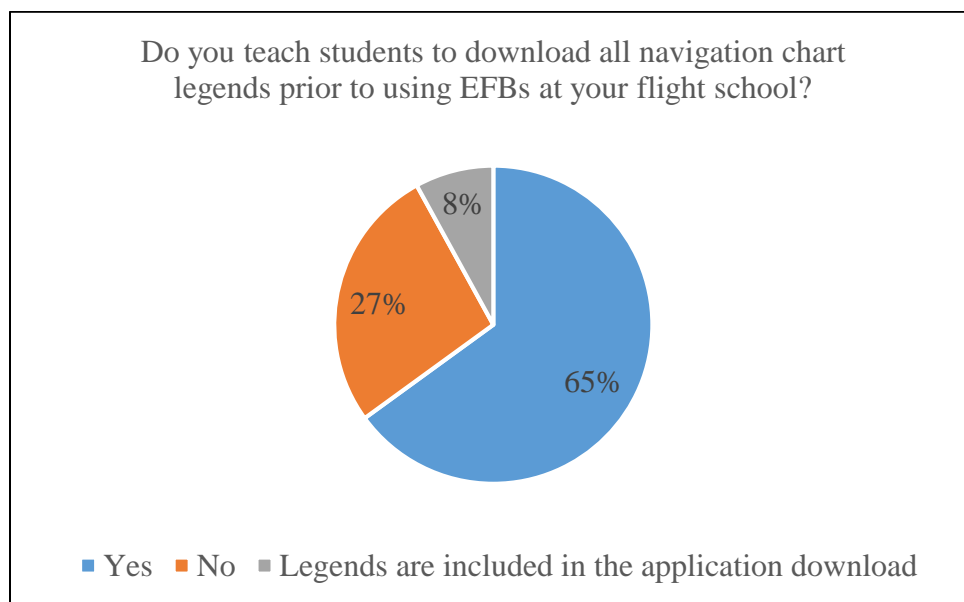


Figure 6. Chart Legend Download Practices as Taught at Flight Schools without EFB Policies.

As previously stated, in the ForeFlight Mobile application, chart legends must be downloaded separately. An understanding of this requirement could then be extrapolated based upon participants' answers. If participants claimed that the legends were included in the default software download, these responses were isolated to determine the type of software used. All applicable responses were linked to ForeFlight Mobile. At flight schools with EFB policies, 10 of the 40 participants (65%) that incorrectly stated legends were automatically included. This means that 65% of these responses indicated a lack of a policy requirement to download the legends. The policies established at these programs did not effectively require legends to be downloaded with the most popular software at their program. As for participants from flight schools without EFB policies, nearly all participants (93%) required their students to download legends.

Though the FAA does not require EFB training in the flight school environment, it is standard practice for air carriers. The following qualitative survey question asked how effectively flight instructors taught EFB software and practices at their program. Results indicated that the presence of an EFB policy is somewhat related to the perception of EFB training quality as indicated by participants. At programs which have EFB policies, 71% of participants either agreed or strongly agreed that EFB practices are taught effectively. At programs which do not have

policies, only 41% of participants agreed or strongly agreed. This data is summarized in Figure 7.

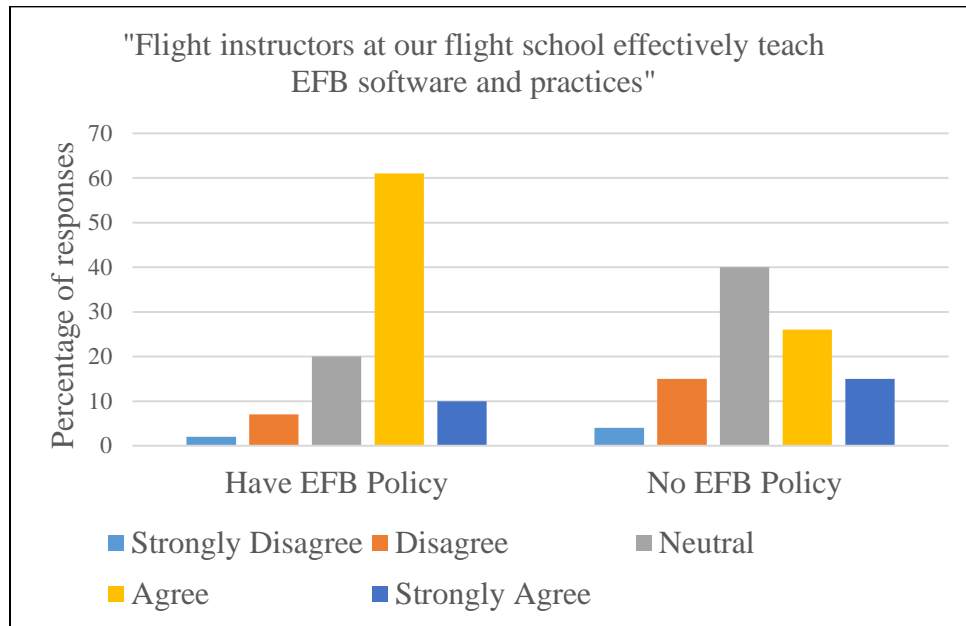


Figure 7. Participant Perceptions of the Effectiveness of EFB Training at their Flight School.

Though the perception of EFB training is somewhat important, the FAA encourages specific training content. The next survey question asked if EFB training included the four training areas as suggested by AC 91.78. These results indicated that the presence of a policy was not necessarily related to conformity to AC 91.78, as participants from schools without policies consistently trained in areas not required by policies at other schools. Also, 55% of participants from schools with EFB policies claimed that none of the four training areas were included in the policy. Once again, EFB practices by instructors with no policy were more conservative than EFB practices under an established EFB policy. These results are summarized in Figure 8.

Although 88% of all participants believed that their EFBs were reliable, EFB battery charge was then investigated for those participants from a program with an EFB policy. These participants were asked if their policy had a required battery charge prior to departure under any conditions. Most of these participants (80%) indicated that their policy does have a dispatch charge requirement. These participants were then asked about their flight school policy's minimum departure

battery charge for a two-hour actual IFR flight, assuming they could not charge the device while flying. Though these participants claimed some policy and/or guidelines at their respective flight program, three stated that they were not sure of the requirement. These responses represented eight different programs. This information is summarized in Figure 9.

Participants at flight schools without EFB policies were then asked a similar question based upon their practices. These participants were asked “What would be your personal minimum EFB battery charge for a two-hour actual IFR flight, assuming you cannot charge the device while flying?” Most responses indicated conservative charges, and were similar to the requirements of EFB policies at other programs and are summarized in Figure 10.

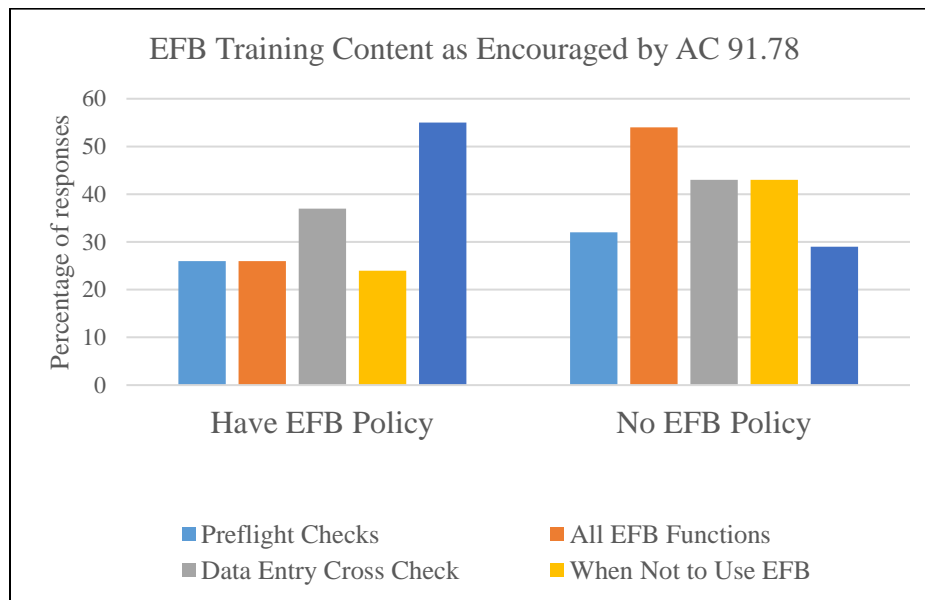


Figure 8. EFB Training Content Included at Participants’ Flight Schools

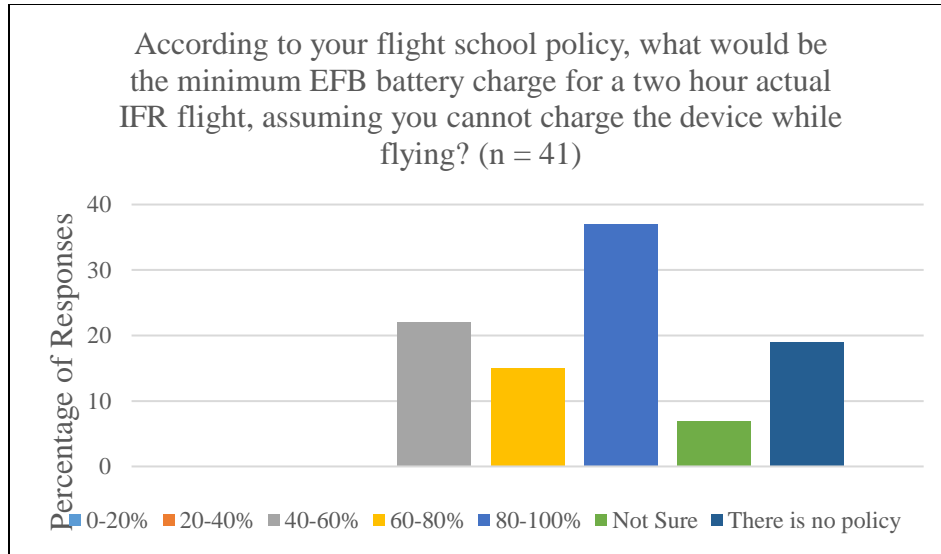


Figure 9. Required EFB Charge for a Two Hour IFR Flight According to Established Policies at Associated Flight Schools.

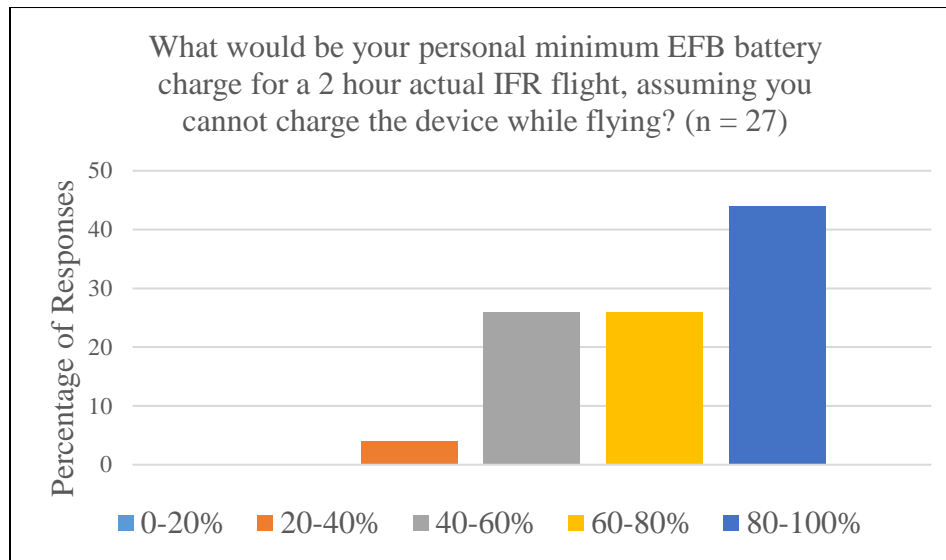


Figure 10. Personal Minimum EFB Charge Prior to a Two-Hour IFR Flight for Participants at Flight Schools without an EFB policy.

The ability to charge an EFB in flight may have affected minimum battery charge for participants at schools with or without EFB policies. However, the presence of EFB policies was not related to the ability to charge an EFB during flight (assuming no external EFB batteries). At flight schools with EFB policies, 25 of 41 participants (61%) could charge their EFB during flight. Respectively, at flight schools with no EFB policy, 19 of 27 participants (70%) could charge their EFB during flight.

As flight schools adjust to EFB use, their fleets may vary in the ability to charge the device in flight based upon hardware. At this point, all participants were asked “How many flight school aircraft are capable of charging your device in flight? Provide your best estimation”. Responses indicated that in flight charging is more prevalent at programs with EFB policies. This data is represented in Table 1.

Table 1
Percentage of Flight School Aircraft Capable of Charging the EFB during Flight at Programs

	0-20%	21-40%	41-60%	61-80%	81-100%	Not Sure
Have Policy	9 (22%)	4 (10%)	0 (0%)	5 (12%)	18 (44%)	5 (12%)
No Policy	7 (26%)	3 (11%)	0 (0%)	5 (18.5%)	7 (26%)	5 (18.5%)

Backup navigation charts are encouraged by both relevant advisory circulars. Participants were then asked if they carried backup charts as either (1) required by their EFB policy or (2) as standard operating procedure without an EFB policy. Most participants (88%) at flight schools without EFB policies indicated that they teach students to carry backup charts. As for the schools with EFB policies, 70% of responses indicated a requirement for a backup chart. Three participants skipped the question. Nearly one in three participants from flight schools with EFB policies stated that backup charts were not required under any circumstances (12 of 40 participants). However, the responses representing flight schools without EFB policies revealed that only 12% (three of 26 participants) never required backup charts under any conditions. In this case, practices and policies were similar, and most programs follow the recommendation to carry backup charts, whether required by a policy or not. This data is represented in Figure 12 and Figure 13.

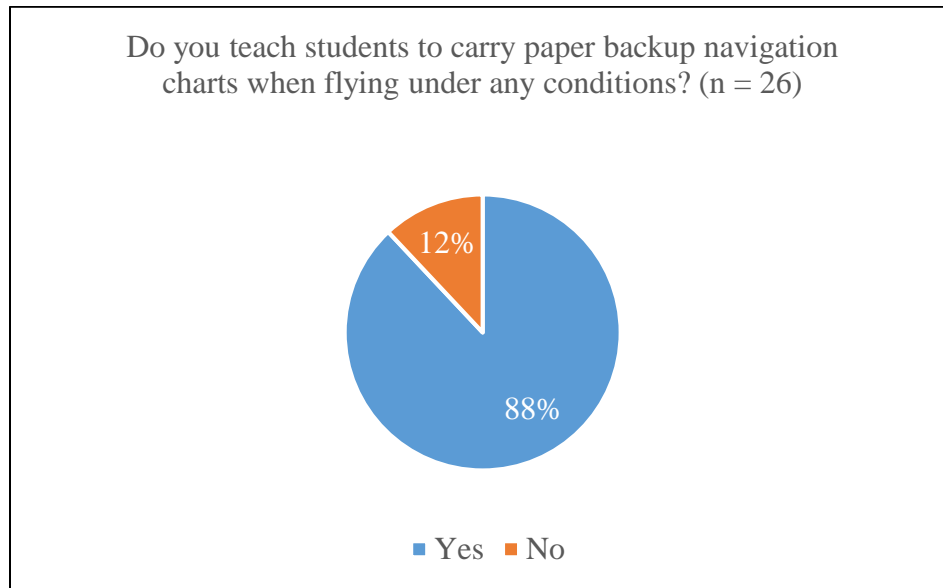


Figure 12. Backup Chart Requirements as Taught at Flight Schools without EFB Policies.

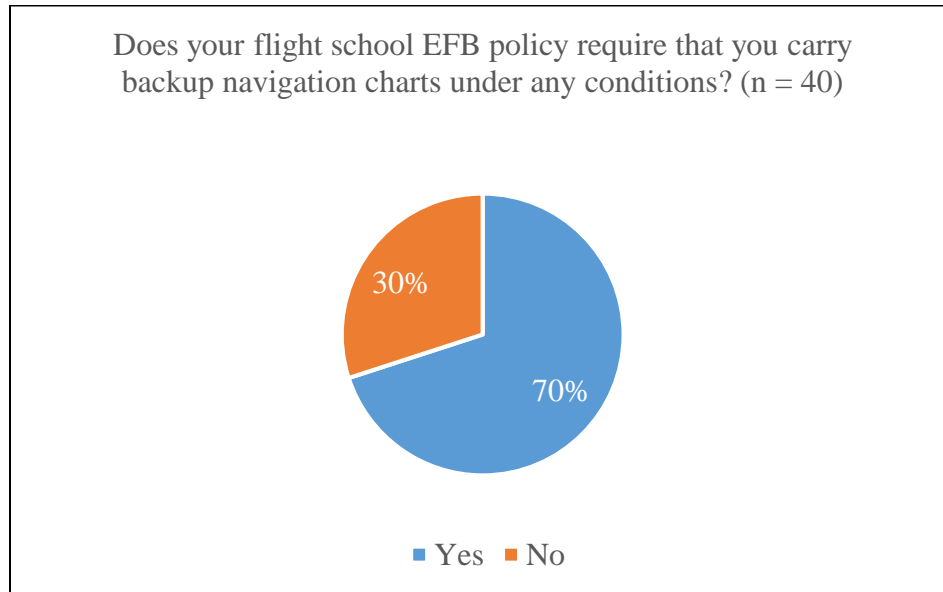


Figure 13. Backup Chart Requirements at Flight Schools with EFB Policies.

When considering backup navigation charts, AC 91.78 encourages a backup chart in either paper or digital format. The next survey question identified allowable backup chart formats and identified when instructors teach students to carry backup charts. Electronic backup charts were allowed at programs with and without EFB policies, with 79% and 70% of responses indicating so respectfully. Paper charts are still common at these programs, as 80% of responses representing flight schools with EFB policies allowed paper backups, and 70% of responses representing flight schools without EFB policies allowed paper backups.

There are several concerns related to the stowage of an EFB in flight when it is not in use. FAA guidance includes concerns about the operation of aircraft equipment, including inadvertent activation of flight controls and/or magnetic interference with the magnetic compass. All participants were then asked if they train their students on how to stow the EFB when it is not in use, and one participant in each category skipped the question. Data indicated that flight schools without EFB policies commonly train students on how to stow the EFB when it is not in use (58% of responses). Only 25% of participants from flight schools with EFB policies were required to teach such practices under the policy.

All participants were then asked which types of EFB functions were practiced at their respective flight program. Most all participants used EFBs for navigation charts, NOTAMs, and preflight weather data, but several also used the EFB for other functions. EFB functions as reported by programs with and without EFB policies are summarized in Figure 14. Other responses included approach plates.

Many flight programs provide EFB support to students in the form of software or hardware subscriptions, software discounts or in-app flight school documents, such as manuals and checklists. Software discounts were common among all programs, with participants with and without EFB policies reporting discounts at 83% and 77% respectively. However, 73% of participants from programs with EFB policies indicated that their software included unique flight school documents in the application, and only 33% from flight schools without policies indicated so. A Chi Square test of independence was used to determine the significance of these results. Programs with an EFB policy are statistically significantly more likely to include in-app flight school documents ($\chi^2 = 4.632$, $p = 0.001$).

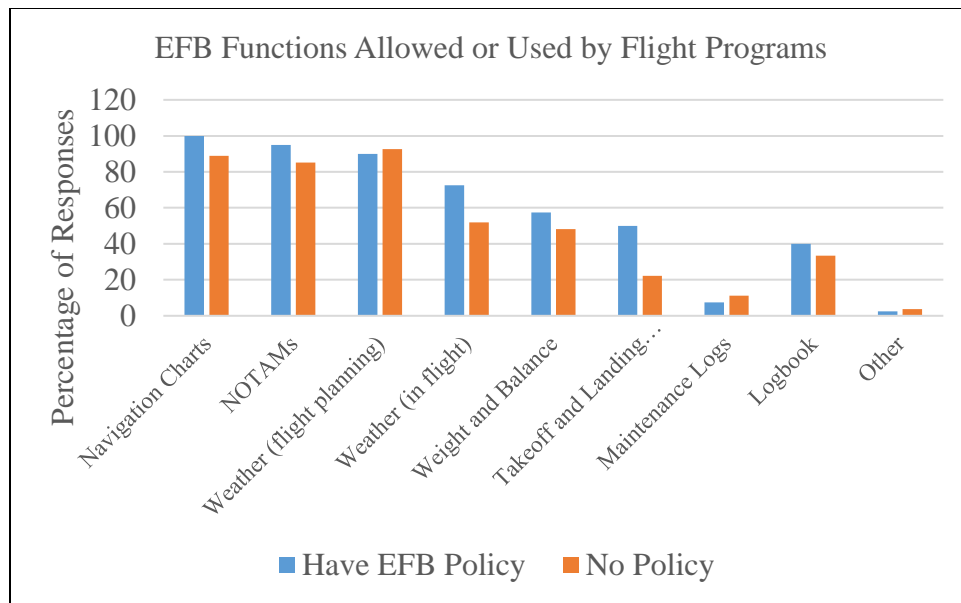


Figure 14. Comparison between EFB functions at flight programs with and without EFB policies.

Discussion

Results indicated that the presence of an EFB policy and/or guidelines had little or no effect upon the quality of EFB practices as encouraged by FAA guidance, despite uniformity in hardware and software combinations. On the contrary, practices at programs without policies better conformed to the FAA's recommendations in several areas as opposed to the requirements of policies at other programs.

Most participants indicated that they use ForeFlight Mobile software. As for air carriers, the software used by each airline is typically standard for all pilots. In the flight training environment, students may choose to use different types of software. The potential result could be that a flight school must accommodate for several different types of software/hardware combinations and each flight instructor may not be able to provide quality instruction for each application. From a practical standpoint, software uniformity is a benefit to a flight program. If all students and instructors use the same software, it is more likely to be fully understood. Fortunately, software uniformity was not an issue.

The acquisition of chart legends was not a requirement for policies at many programs. Legends are essential for initial training, and should be downloaded as appropriate. When downloaded on an iPad, the ForeFlight Mobile application requires pilots to download legends separately. Results indicated that many instructors were not aware to this requirement. If downloaded on an iPhone, the legends are included in the software, but the retrieval and usability of the legends is hampered. Most of the software's functions are streamlined and similar to use across the two devices, but access to chart legends are not.

At many collegiate aviation programs, EFB training is either lacking or nonexistent. Policies at some flight schools did not require training in any of the areas as recommended by Advisory Circular 91.78, despite the perception of better EFB training at these programs. The actual training deficiency is somewhat reflective of feedback from airline pilots, as they commonly report poor initial EFB training from their air carriers. This is a concerning discovery and should be addressed at both flight schools and air carriers.

Although EFBs are certainly common for flight training, most participants felt that a paper chart and E6B flight computer were essential for private pilot training. From an instructor's perspective, a basic understanding of flight planning is required to properly use flight planning software. This includes planning for course, speed, time, and fuel. However, as EFBs continue to provide more and more capabilities, it seems certain that the days are numbered for paper charts and E6B flight computers.

Nearly 80% of participants in both samples stated they received some type of discount for their software subscription. However, programs with policies more commonly included flight school documents such as checklists and standardization manuals. The inclusion of this information in the application is certainly a convenience to students and instructors alike.

In general, responses from all participants indicated adequate EFB charge for a two-hour IFR flight based upon typical battery consumption whether required by a policy or not. A minimum battery charge is recommended by the FAA and most instructors without policies teach the concept anyway. With this in mind, it is logical to encourage a battery charge requirement if developing a flight school EFB policy. Three of the 41 participants with policies (7%) admitted they had a requirement but did not know it, and only one participant without a policy indicated a minimal charge under these conditions.

There were 22 faculty participants, and many of these participants claimed ignorance to detailed questions, like those related to DPEs allowing EFB use on a private pilot check ride. However, as faculty members teaching flight courses, they should be aware of EFB practices as suggested or required by flight instructors or established policies. An effective program integrates coursework and flight training, and the use of an EFB in the classroom can benefit both instructors and students.

There were six programs which had at least three participants. With this data, conformity of survey responses was then analyzed relating to the question “Has your flight school implemented an EFB policy and/or guidelines?”. Four of the six programs had complete uniformity in their responses, and two of the programs did not. This may indicate some confusion at certain programs about EFB policies.

Limitations

There were 17 participants from one program and 10 from another. This may have impacted the raw data that was collected. However, there were a total of twenty different programs represented by at least one participant.

Participants may have not been aware of policy requirements, even though their program had one. This was evident on a few questions where they claimed ignorance to a battery charge requirement. Two programs had multiple participants which answered questions differently. This may reflect poor EFB training at these programs, or a poor knowledge base for participants. Either way, it may have affected the raw data.

The overwhelming presence of ForeFlight Mobile in the programs represented also presents a limitation. If a program were to choose another software, some of this data may not apply, such as battery tablet charge or the requirement to separately download legends. The software itself affects all of this data, and most data gathered reflected one type of software.

Recommendations

At the very least, it is recommended that flight programs develop a simple EFB policy. The recommendations of AC 91.78 suggest only four areas of training. Collegiate flight programs could also use air carrier policies and or AC 120.76C for reference. As for software, it is recommended that a program select one software

and encourage or require that software. In this scenario, students, instructors, and faculty can master one type of software instead of trying to work with several types.

As for EFB software developers such as ForeFlight Mobile, it is apparent that collegiate programs continue to require hand-written navigation logs including more detail than is offered in the application's navigation panel. Most participants in this research (96%) stated that their programs' navigation logs required true course, wind correction angle, and magnetic variation. Also, most participants (66%) were insistent upon students using paper charts and flight computers for flight planning during private pilot training. This data is not included in many EFB applications, but could be in the future to streamline flight training with software products. For example, a pilot first learns about true course during private pilot training, and the data collected indicated many pilots using software for primary (initial) training. Pilots in training would benefit if the software and flight training provided and solicited consistent information.

More than half of all participants (54%) indicated that their pilots must delay EFB use until instrument training. This may suggest that these programs insist that students initially master paper sectional charts and/or the E6B flight computer. One approach to EFB integration would be to begin basic EFB training with the instrument rating, and then add EFB functions such as performance and weight and balance calculations during commercial and multiengine training.

Conclusion

Overall, EFB practices at all represented programs somewhat conformed to Advisory Circular 91.78. Flight programs with EFB policies are more likely to share flight school documents and operate airplanes capable of charging an EFB in flight, but the training at these programs was not sufficient. Several programs have no battery charge requirement and/or established EFB training programs. However, EFB training at programs without EFB policies either met or exceeded the FAA's recommendations more often. The lack of an EFB policy is not related to poor EFB practices, but implementing a policy controlled by the flight program may increase the quality of the collegiate pilot training experience.

Suggestions for Future Research

The battery consumption rates and associated minimum battery charge data assumed a predetermined battery consumption of 10-20% per hour as indicated by ForeFlight Mobile. However, during flight, it is doubtful that a pilot would continuously use the tablet. It would be beneficial to determine realistic EFB use

times per hour of flight and per type of flight (i.e. IFR or VFR) for realistic battery charge requirements, especially if one assumes a pilot cannot recharge an EFB during flight.

Many participants indicated using the EFB for weight and balance and performance data. This is a common practice among professional pilots, and current research efforts are diving into the issue of cross checking data entry to prevent incorrect takeoff data. This concern should be carefully considered by collegiate training programs and air carriers.

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