General Aviation CFI Weather Training

FAA Grant #00-G-020

Final Report
(second part of the grant)

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September 2002

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Executive Summary

Weather-related accidents in general aviation (GA) continue to claim many lives every year (Aircraft Owners and Pilots Association, AOPA, 2001). However, what GA pilots are taught about weather during their earliest training is largely unknown. Likewise, it is unclear to what degree GA pilots have a solid base of weather knowledge that has relevance for real flight operations. The General Aviation Pilot Weather Knowledge and Training Study was proposed to provide information regarding these two areas. Thus, it was actually comprised of two separate studies: "The Weather Knowledge Challenge" and the "CFI Weather Training Survey." The Weather Knowledge Challenge was used to assess the knowledge that certificated U.S. pilots, at all training and experience levels, have regarding content in six weather categories: Causes of Weather and Weather Patterns, Weather Hazards, Weather Services, Weather Regulations, Weather Interpretation, and Weather-Related Decision Making. The CFI Training Survey collected information from certified flight instructors (CFIs) regarding the weather training they provide to primary student pilots.

The Weather Knowledge Challenge

Over one thousand pilots, who attended the EAA Airventure Fly-In at Oshkosh, Wisconsin in July 2000, completed a weather knowledge test, which had been designed to assess operational weather knowledge that should be mastered by, at a minimum, VFR-only pilots. The major findings of this study were that:

- In general, participants performed quite poorly on The Weather Knowledge Challenge. Many pilots apparently lack operationally relevant weather knowledge and/or have difficulty recalling what was once learned.

- The influence of gender, total hours of flight experience, and amount of flight experience within the preceding six months were each individually found to be significantly related to performance on the Weather Knowledge Challenge. However, all significant differences found related to gender and flight experience disappeared when evaluated in conjunction with participants' level of formal training (VFR-only, instrument-rated, CFI, ATP). Therefore, it appears that pilots generally require formal training to obtain weather knowledge and cannot be expected to acquire it on their own as they simply gain more flight experience.

- VFR-only pilots performed significantly worse than the other three groups did. Likewise, instrument-rated pilots performed significantly worse than CFIs and ATPs. The performance of CFIs and ATPs did not differ significantly from each other. However, all four groups, including CFIs and ATPs, performed poorly on The Weather Knowledge Challenge.

- Prior to completing the tests, pilots rated their mastery of weather-related decision making significantly higher than their mastery of content in the other five weather categories. However, their self-ratings for mastery of content in all six categories were in the Fair to Good range.

- After having completed the tests, the pilots rated their actual performance significantly lower than they had rated their mastery of weather category content prior to having taken the test. However, these subjective ratings of how they had performed were still generally better than their actual performance. Hence, many pilots do not have accurate perceptions regarding their levels of weather knowledge.

- Pilots tended to perform the best on items that were designed to be "pure" measures of knowledge of weather hazards and of weather-related decision making. Pilots tended to perform the worst on items that were designed to be pure measures of knowledge of weather interpretation and of weather services. Pilots at all levels of formal training, but particularly those who were certificated to fly only in visual meteorological conditions, generally had difficulty in integrating weather knowledge from several of the six different weather categories (e.g., weather hazards, weather services, weather interpretation, and weather-related decision making). All participants, but VFR-only pilots in particular, also had difficulty in demonstrating an understanding of the implications weather information has for real flight operations.

- Pilots at all levels of formal training had difficulty on items that required them to "decode" information in various weather products (e.g., METARs, TAFs, Winds Aloft Table, etc.) or to read various weather charts.

- All pilots, including many instructors, were unable to select correct answers for VFR weather regulations questions. Only 44.7% of all pilots were able to correctly identify Marginal VFR visibility and ceiling levels and 45.9% of all pilots actually incorrectly identified IFR visibility and ceiling levels as those that constitute Marginal VFR.

<u>CFI Weather Training Survey</u>

CFI participants were recruited through Part 141 schools and notices posted on the AvWeb/AvFlash, NAFI e-Mentor, AOPA, and TheCFI.com websites. Completed paper/pencil versions of the survey were returned by 177 CFIs and 233 CFIs completed the survey on-line. The surveys were designed to elicit information from active CFIs about the weather instruction they provide to primary student pilots (i.e., those students working toward a Private Pilot Certificate). The major findings of this study were that:

- CFIIs report placing greater emphasis on 17 of 34 different weather topics, grouped into six different weather categories, than CFIs do during the training of primary student pilots. However, CFIIs and CFIs do not differ in the amount of emphasis they report giving to Weather-Related Decision Making topics.

- Participants, who instruct under FAR Part 61 only, report placing significantly less emphasis on 27 of the 34 weather topics during training with primary students than their counterparts who teach also or only under FAR Part 141 and/or in academic settings.

- In terms of the reported emphasis given to teaching weather topics, CFIs who teach under both Part 141 and Part 61 bear greater resemblance to CFIs who teach only under Part 141 than to CFIs who teach only under Part 61.

- During instruction with primary student pilots, participants report that they place the least amount of relative emphasis on most topics related to the Basic Causes of Weather and to Weather Services. Participants indicated that they give the greatest emphasis to topics pertaining to Weather Regulations and to Weather-Related Decision Making.

- Although CFIs indicated that Weather-Related Decision Making was that category that held the greatest importance for training primary student pilots, in actuality it was found that they spend the greatest amount of time covering Weather Regulations topics. CFIs also appear to think that they emphasize Weather Hazards topics to a greater degree than they do in actual practice.

- All participants, regardless of their level of instructor rating or experience, or where/under which FAR Part they instruct, tend to spend around five to six hours during ground school and around five to six hours in-flight instructing their primary student pilots about weather. This appears to contradict the earlier finding of significant differences in the amount of emphasis reportedly given to individual weather topics due to type of instructor rating and where/under which FAR Part they instruct.

- Participants reported feeling very confident that they had mastered the content in the six different weather categories. However, participants rated the quality of instruction they provide in these same six categories significantly lower. Thus, the participants believe that they, themselves, understand weather material better than they are able to teach it to their students.

- An overwhelming majority of the participants advocate the practice of exposing primary student pilots to marginal weather conditions during training. Further analyses revealed that participants who instruct only under Part 61 were significantly stronger advocates of this practice than those who instruct also or only under Part 141 and/or Academia. No differences in this attitude were found between CFIs and CFIIs or between instructors with the lowest and highest amounts of experience.

- Four-fifths of the participants reported that they had actually flown with students into marginal conditions (around 2 times with each student). The most popular way to do this was for the instructor to file an IFR flight plan and fly in real IMC conditions with the student on-board. A very large number of instructors also reported that they make a point of flying in windy or turbulent conditions with their students.

- CFIIs were significantly more likely than CFIs to report having flown with students in marginal weather conditions. Likewise, instructors with the highest amounts of teaching experience were significantly more likely to report having done so than instructors with the lowest amounts of teaching experience. Instructors in the Part 61 Only group also appear to do this to a significantly greater degree than their colleagues instructing also or only under Part 141 and/or Academia.

- In summary, only a few differences were found between instructors related to their level of instructing experience (high or low). However, instructors who teach only under Part 61 appear to differ on several dimensions from those who instruct also or only under Part 141 and/or in academic institutions. Likewise, several differences were found between CFIs and CFIIs related to various facets of weather instruction with primary student pilots.

Conclusion

All participants, including flight instructors, appear to believe that they generally have a good understanding of weather and a broad base of aviation weather knowledge. However, none of the participants in this study, as a group, demonstrated a strong understanding of weather as it pertains to real flight operations. Pilots, CFIs, researchers, training material developers, and the FAA each have a role to play if we are to improve the state of pilot weather training, increase the level of pilot weather knowledge and understanding, and have a real and positive impact on general aviation safety related to weather.

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Introduction

It is well known that poor or hazardous weather conditions continue to play a central role in many general aviation (GA) incidents and accidents (Aircraft Owners and Pilots Association, AOPA, 1996; National Transportation Safety Board, NTSB, 1989). When these accidents occur, often the results are fatal. In 1999, 75% of all weather-related GA accidents resulted in fatalities (AOPA, 2001).

Under "Safer Skies – A Focused Agenda" the FAA identified "weather" as one of the primary safety issues needing to be addressed within General Aviation. A Joint Safety Analysis Team (JSAT) met several times to review a representative sample of GA accidents involving weather and identified seven root causes for these accidents, the first pertaining to pilots: "Inadequate initial and continuing pilot education and formal operational procedures for making weather decisions" (FAA, 1999, p. 12). Intervention strategies suggested by the JSAT to address this root cause related to improving initial and continuing education in order to increase GA pilot knowledge, skill and judgement in weather-related decision making (FAA, 1999).

To this end, the FAA Aviation Safety Program, as well as many other aviation organizations (e.g., AOPA) sponsor numerous safety workshops each year, many on weather-related topics. Two computer-based training (CBT) CD-ROMs have also been developed related to improving GA decision making. "Making Your Own Rules: Creating a Personal Minimums Checklist" (1999) is an effective CBT through which pilots are introduced to the idea of setting personal minimums for making a go/no-go decision. Some of the factors the CBT pilot users consider as they develop their own minimums checklists pertain to weather. In "Weather Wise" (1999), another FAA CBT, GA pilots sharpen their weather decision making skills as they learn to "read the weather out the cockpit window" and "recognize hazardous weather conditions." Although users, by virtue of having completed the CBTs, may gain some weather knowledge, both were designed with the expectation that pilot users would already have a good knowledge base regarding weather as their focus is on strengthening decision making skills.

Pilot decision making skills and strategies have also been the focus of much of the research related to GA weather-related accidents; the consensus in the aviation community is that many of these accidents stem from "pilot error" most notably, poor weather-related decision making (National Aviation Weather Program Council, 1997; Sand and Biter, 1997). Some researchers have examined the role that expertise has on aeronautical decision making more generally (Driskill, Weismuller, Quebe, Hand, & Hunter, 1998; Guilkey, Jensen, Caberto, & Fournier, 1995; Kochan, 1995) as well as in weather-related decision making, more specifically (Wiggins & O'Hare, 1995). Research has generally found differences in the quality of decisions made by novice pilots compared to those with greater expertise. As a result, some researchers have suggested teaching novices the decision making strategies employed by experts, thereby circumventing the time needed for a novice pilot to gain expertise (Orasanu, 1995). What is

often overlooked, however, is that experts also typically have more knowledge than novice pilots do. Good decisions are not made in a vacuum but ensue from a solid knowledge base.

Researchers have also investigated other factors believed to pertain to GA weather-related accidents. Some have examined the amount of consideration or "worth" pilots give to different weather and terrain variables when planning cross-country flights in light aircraft (Driskill, et al.,1997; Driskill, Weismuller, Quebe, Hand, & Hunter, 1997; Martinussen, Hunter, & Wiggins, 1998). Others have focused upon the cognitive processes involved in making weather-related decisions (O'Hare & Smitheram, 1995) and pilot situational awareness of deteriorating weather conditions (Layton & McCoy, 1989; McCoy, Woleben, & Smith, 1994). Thus, although researchers have examined higher order cognitive processes and strategies to identify shortcomings in pilot weather-related decision making, none have examined pilots' weather knowledge bases, from which these decisions are derived, or the training the pilots' received whereby their knowledge bases were established.

Knowledge, Training the and Role of Certified Flight Instructors (CFIs)

Besco (1989) identified five factors commonly associated with pilot performance: knowledge, skills, attitudes, obstacles, and the systems environment. Although a deficiency in one alone is sufficient to lead to pilot error, they are inter-related and often co-occur in accidents in which "human error" is cited as a cause. Some skills can be learned by rote and performed without demonstrating real understanding and knowledge about the skill. For example, a student pilot can be taught to correctly apply right rudder pressure upon take-off to "keep the nose straight" without knowing or understanding concepts such as slipstream forces on the empennage, engine and propeller torque, gyroscopic precession, or propeller P-factor.

Some pilots may make weather-related decisions using a set of heuristics or "rules of thumb" which do not require that they have a thorough understanding of weather and the implications it has for flight. For example, VFR pilots flying in the Eugene, Oregon area might use the relationship of the cloud base to the tops of the Coburg Hills to determine whether or not to fly – "If the clouds hit the tops of the hills, I won't go flying." Heuristics like this one do not require large amounts of information or much processing by the pilot. Pilots who use such weather heuristics may fly quite safely as long as they follow them and do not venture out of the physical environment where they apply (R. Mauro, personal communication, August 21, 2002).

Critical thinking and decision making skills that are not based upon the use of heuristics or "rules of thumb" require that much more information be available to be processed. Information alone is not sufficient for good decision making to occur, though; in-depth knowledge and understanding of the information are crucial but often overlooked elements (Adams, 1997; Glaser, 1984).

Thus, pilots will often be unable to make good weather-related decisions if they lack a good fund of weather knowledge – to be distinguished from just having weather information (Sand & Biter, 1997). A pilot's weather knowledge base is typically established during his or her initial training and develops as he or she gains experience, obtains more advanced levels of pilot certification and ratings, learns from the experiences of others, and develops greater comprehension through continuing education materials and programs. However, if "weather" is neglected or given only cursory coverage during initial training, pilots will find it difficult to add to or shore up this weak

and "crumbling" foundation later. Indeed, most student pilots look to their CFIs as their primary source of information when developing their knowledge bases and may lack the motivation or ability to obtain, understand, or integrate weather knowledge on their own.

To develop a better understanding of GA pilot decision making related to weather, we must first explore CFI weather training practices. Indeed, the kind, content, and quality of weather training has often been overlooked (Office of the Federal Coordinator for Meteorological Services and Supporting Research, OFCM, 2002). What and how do CFIs teach student pilots about weather? How much emphasis is given to different weather topics? Do CFIs themselves have a thorough understanding of weather as it relates to aviation operations? What is the quality of the weather-related instruction CFIs give? As CFIs are the "foundation of the learning pyramid" (R. Baker, e-mail communication, February, 10, 2000) it is particularly important to assess deficiencies in their weather knowledge bases. If CFIs lack weather knowledge themselves, they will be unable to transmit information pertaining to weather correctly or at all to their students.

Little information has been available regarding private pilot and instructor knowledge about weather. Performance data from FAA written exam weather questions are not available separately from an applicant's overall exam score. Likewise, no information has been available pertaining to CFI training practices regarding weather when instructing primary student pilots.

A clearer understanding of CFI training practices, pilot knowledge bases and deficiencies, and pilots' abilities to apply weather knowledge will allow us to better evaluate errors in weather-related decision making and develop more effective training and intervention strategies.

The Current Study

The General Aviation Pilot Weather Knowledge and Training Study was comprised of two distinct parts: "The Weather Knowledge Challenge" and the "CFI Weather Training Survey." The Weather Knowledge Challenge was used to assess the knowledge that certificated private pilots at all training and experience levels, including CFIs, have regarding content in six weather categories: Causes of Weather and Weather Patterns, Weather Hazards, Weather Services, Weather Regulations, Weather Interpretation, and Weather-Related Decision Making. Through the CFI Weather Training Survey, CFIs provided information regarding the weather training they provide to student pilots. The methodologies used, results and discussion of the findings for The Weather Knowledge Challenge and the CFI Weather Training Survey are presented separately below.

CFI Weather Training Survey

What might explain the generally poor operational knowledge about weather that pilots displayed when taking the Weather Knowledge Challenge? To answer this we must start by examining the state of pilot weather training. The CFI Weather Training Survey assessed the earliest training given to pilots about weather – that given to student pilots who are working toward a Private Pilot's Certificate – as reported by those who provide it: certified flight instructors.

Method

Participants

Participants were CFIs, living and instructing within the United States of America, Puerto Rico, or the Virgin Islands, who had instructed at least one primary student pilot in the preceding three years (this served as the definition of "actively instructing" for the purposes of this study). Participants were recruited through three primary sources: FAA-Approved Part 141 Schools, the National Association of Flight Instructors (NAFI), and a posting/notice on the AvWeb website. Procedures used for sampling from each source are described below. Regardless of the source of recruitment, all CFIs were instructed not to complete the survey if they had previously already done so.

Measure

Depending upon the source through which the participants were recruited, CFIs completed a paper-pencil version (see Appendix F) or an almost identical on-line version of the survey (see Appendix G). In the first section of the survey CFIs were presented with 34 different weather topics that were grouped into six different weather categories: Causes of Weather, Weather Hazards, Weather Services, Weather Regulations, Weather Interpretation, Weather-Related Decision Making. They were asked to indicate the total amount of training they provided to their student pilots on these topics over the entire course of the students' training for the private pilot certificate. CFIs indicated these amounts using a 5-point Likert scale with an additional answer option of N/A ("No training given by you on this topic"). Only points 1 and 5 were given text anchors: 1 = A little, approximately 1 to 30 minutes; 5 = A Great Deal, approximately 4-8 hours.

In Section II, CFIs rated the degree of confidence they had in their own mastery of information in the six different weather categories using a 5-point Likert scale: 1 = No Confidence, 2 = Slightly Confident, 3 = Moderately Confident, 4 = Very Confident, 5 = Extremely Confident. Similarly, in Section III CFIs were asked to indicate, as honestly as they could, the quality of the instruction they provide to their student pilots in the same six weather categories using the following scale: N/A = No Instruction, 1 = Very Poor, 2 = Poor, 3 = Adequate, 4 = Good, 5 = Very Good.

Section IV of the survey contained a variety of different questions. CFIs were first presented with the six different weather categories and asked to rank order them (with no "ties" in their rankings) in terms of the importance they feel each category has for the training of student pilots

(1 = most important, 6 = least important). CFIs were also asked to estimate the amount of time they spend covering weather-related topics during ground school and in-flight (which includes preflight and post-flight briefings); for this question CFIs were told to assume that they were instructing a primary student with no prior training.

CFIs were also asked to respond to open-ended questions regarding the problems they saw, if any, with regard to training student pilots about weather and about all the factors the CFIs believed should be considered by student or new private pilots in making a "go/no-go" decision. CFIs were also asked to indicate their stance on exposing student pilots to marginal weather conditions during flight training (-3 = Strongly Against, 0 = Neutral, +3 = Strongly For). CFIs were then asked if they had ever taken a student pilot into marginal weather conditions during flight training on purpose and to indicate the ways in which they had done this (e.g., Fly into a cloud; Fly into an area of visibility less than three miles; File IFR, in true IFR conditions, and have my students ride along; etc.).

In Section V of the paper-pencil version of the survey (Section VII of the on-line version) the CFIs were asked to give examples of how they both teach and assess weather-related decision-making with primary student pilots. CFIs were asked to sign their initials if they were willing to have their responses (to this section only) posted on a website designed to assist and give training suggestions to CFIs. Dr. David Hunter of the FAA Office of Aviation Medicine is developing this website.

Questions in Section VI were used to gather demographic and background information about the CFIs. CFIs were also asked to provide their zip codes. These were collected so that CFIs who had completed the survey more than once could be identified. The on-line version of the measure contained three additional questions in this section. The first asked respondents to indicate how they had heard about the survey (through NAFI, AvWeb, or some other means). The other two questions asked CFIs to indicate when they had last renewed their CFI certificates and to describe the ways in which they had most recently renewed their CFI certificates. These questions were asked in an attempt to identify respondents who had completed the survey but who were not actually CFIs themselves. Because of the way in which the paper-pencil surveys were distributed (see below) we were more confident that the respondents were indeed CFIs; with surveys that appear on the web where access is made public, additional safeguards must be taken to ensure, to the greatest degree possible, that respondents are truly members of the population of interest.

The final section of the paper-pencil survey (Section V of the on-line version) consisted of thirty statements. CFIs were to indicate the degree to with they agreed or disagreed with each statement; response choices were Strongly Agree (SA), Agree (A), Neutral – neither agree nor disagree (N), Disagree, (D), or Strongly Disagree (SD). Twelve of the statements were designed to serve as an impression management scale; the other 18 were filler items. Half of the scale items as well as half of the filler items were written in the positive direction; the others were written in the negative direction (see Appendix H). It was believed that some CFIs might respond to the entire survey with a response set to positively manage the impression others might have of them. This tendency is common in self-report surveys such as this one. Thus,

impression management scale items were developed to identify those CFIs who responded in such a manner.

Some of the impression management scale statements contained language that was equivocal (e.g., "sometimes," "occasionally"). However, some of the statements contained language expressed in absolutes (e.g., "always," "never"). This mix was used purposefully. Most of the scale items described behavior that might be desirable (or even "required") but unlikely to be performed all the time by even the most conscientious, patient, and knowledgeable CFI. An *a priori* decision was made that individuals selecting "Strongly Agree" for all six scale items written in the positive direction (e.g., "I never get frustrated by students when they ask me questions") and "Strongly Disagree" for all six scale items written in the negative direction (e.g., There have been times when I have skipped a thorough preflight inspection of the plane before flying") would be identified as "high impression managers" and their data would be eliminated from the data set prior to conducting analyses.

Procedures

Participants were obtained through three different sources; procedures for gathering data through each of these sources differed and are described separately below. The source through which each respondent was recruited was recorded during the data collection process. Data collection occurred during the fall of 2001 and spring of 2002.

A list of FAA approved Part 141 schools and training centers was obtained from Dr. David Hunter in the FAA Office of Aviation Medicine. A letter describing the survey and its purpose was sent to the chief pilot in charge of training at each of the 465 Part 141 schools on the list. Chief pilots were asked to return an enclosed postage-paid postcard if the CFIs in their school were willing to participate with an indication of the number of surveys needed.

Each survey packet mailed to the chief pilots for distribution to their CFIs included the following: a cover letter that provided informed consent to the CFI, a blank paper-pencil version of the survey, an addressed and stamped return envelope, and a blank mailing label. The cover letters explained the purpose of the study and indicated that although the survey was being funded by the FAA, the FAA would not be privy to individual CFI responses except for Section V responses and then, only if CFI permission was given. CFIs were instructed to complete and return the surveys and to self-address and return the blank mailing labels if they wanted to receive a summary of the survey results. Mailing labels were separated from completed surveys immediately upon receipt. To summarize, chief pilots of the Part 141 schools indicated how many surveys, if any, would be needed and were responsible for distributing the survey packets to CFIs. However, individual CFIs were responsible for actually returning the completed surveys to the co-principle investigator of this study. Approximately four weeks after the survey packets were sent, reminder postcards were mailed to the chief pilots requesting that they encourage their CFIs to complete and return the surveys if they had not already done so.

The National Association of Flight Instructors (NAFI) distributes a monthly newsletter, the "NAFI Mentor," to its members. The "NAFI e-Mentor" is the on-line version of this newsletter. Mr. Greg Laslo, the managing editor of the "NAFI e-Mentor," included a small notice regarding the survey in this on-line newsletter. The notice described the purpose of the survey and

instructed active CFIs who wanted to participant to contact the co-principal investigator of this study via mail or e-mail to obtain a paper-pencil version of the survey. The web address for the on-line survey was also included in the notice for participants who preferred to complete that version instead. Individuals who requested a paper version of the survey were sent the same survey packet as that used with Part 141 school CFIs (see above). CFIs who completed the survey on-line first read an identical cover letter as that used with the paper-pencil versions before responding to survey questions.

There are a number of aviation-related websites available through the Internet and the "AvWeb" Website is one of the more popular ones. In addition to maintaining their website, "AvWeb" also distributes a twice-weekly, electronic news bulletin entitled "AvFlash" to interested subscribers. The editorial board of "AvFlash" was contacted and asked to post a notice regarding the survey both on their Website and in the AvFlash news bulletin. This notice was almost identical to that which appeared in the NAFI newsletter except that CFIs were only invited to complete the on-line version of the survey. A hotlink to the on-line survey web address was included in the notice.

The Aircraft Owners and Pilots Association (AOPA) sponsors several CFI Re-certification Workshops across the United States every month. Mr. John Steuernagle of AOPA's Air Safety Foundation indicated that CFI re-certification workshop leaders were willing to distribute surveys to eligible and interested CFIs attending those workshops. Further conversations with Mr. Steuernagle and Mr. Dick Hiner revealed that, because of the logistics required in distributing surveys with the least amount of disruption, it would not be worth the cost of distributing surveys through the workshops given the number of completed surveys that were expected to be returned. Thus, although we initially planned to collect data through this source as well, we decided not to pursue this option. Mr. Steuernagle and Mr. Hiner were quite helpful, however, in getting the notice of this survey (with the on-line web address) posted on the AOPA website and connecting us with Mr. Mike Mechsner who likewise posted a notice regarding the on-line survey on the website he manages: www.TheCFI.com.

Results

Response Rate

The chief pilots from the Part 141 schools returned 107 postcards requesting that a total of 1,251 surveys be sent. Only 173 CFIs from the Part 141 schools actually completed and returned surveys, however, yielding a 14% response rate. Six CFIs responded to the notice in the "NAFI e-Monitor" and requested a paper-pencil copy of the survey; five of these individuals returned completed surveys. A total of 526 individuals logged on to the on-line survey website in response to the notices posted in the "NAFI e-Monitor," "AvFlash," and on the AOPA website. However, 190 logged-on, read the description of the survey, and then left the site without completing any of the survey sections and only 238 completed all seven sections of the survey – a response rate of 45%. No participant was identified as having completed the survey more than once using a check of zip codes and other demographic and background data. Likewise, to the degree possible, it was determined that all respondents who completed the on-line version were

indeed CFIs based upon their responses to specific questions that were designed for this purpose and were included in the on-line version only (described earlier).

Impression Management Scale

As discussed above, it was believed that some CFIs might respond, consciously or unconsciously, to the entire survey with a response set to positively manage the impression they were giving of themselves. To identify CFIs, who were responding in such a manner, an impression management scale was devised. Six individuals (one who completed a paper-pencil version of the survey and five who completed on-line versions) were identified as "high impression managers" through this scale in the method described earlier. After their responses to the surveys were removed, the data from 410 participants remained (See Table 8a in Appendix I) and were subjected to the analyses reported below.

Comparison of Participants who Completed Paper-Pencil and On-Line Versions of the Survey

As can be seen in Table 8a, data retained for analysis in this study were collected from 177 CFIs (43.2%) who completed a paper-pencil version of survey and 233 CFIs (56.8%) who completed the on-line version. These two groups were compared on a number of variables. They did not differ in terms of the total number of flight hours they had logged (t (403) = -.58, p = .56) nor by the number of hours of flight instruction they had given (t (403) = .40, p = .69) or the number of years that they had been instructing (t (404) = -.51, p = .61).

They did differ significantly, however, in terms of their mean ages (t (329.5) = -3.58, p < .001). The participants who completed the paper-pencil version of the survey (M = 39.19, SD = 16.00) were significantly younger than those who completed the on-line version (M = 44.50, SD = 13.03). The paper-pencil group also reported having given a significantly greater number of hours of flight instruction over the preceding three years (M = 626.29, SD = 525.53) than the on-line group reported having given (M = 491.38, SD = 467.67; t (400) = 2.71, p < .01). Similarly, the paper-pencil group indicated that they work with a significantly higher average number of students per year (M = 9.77, SD = 8.85) than those who completed the on-line survey (M = 7.01, SD = 7.50; t (320.6) = 3.24, p < .01).

Significant results from a Chi-Square analysis (X^2 (1) = 37.29, p < .001) indicated that participants who completed the paper-pencil survey were more often full-time instructors (n = 112, 64.4%) rather than part-time instructors (n = 62, 35.6%) and those participants who completed the survey on-line were far more likely to instruct part-time (n = 150, 66.4%) rather than full-time (n = 76, 33.6%).

Unfortunately, the significant differences found between the on-line survey and paper-pencil survey groups just described are likely artifacts of the data collection strategy. This is explored in greater detail in the Discussion Section.

Participants

An overwhelming number of the 410 CFI respondents were male (n = 357, 87.1%) rather than female (n = 49, 12.0%). Four respondents did not indicate a gender. Respondents ranged in age from 19 to 76 years with a mean age of 42.22 years (SD = 14.6). The median age of the survey respondents was 43 years. As can also be seen in Table 8b

(found in Appendix I), respondents reported a mean of 1560.97 hours of flight instruction given (SD = 3867.40) with a median of 1,700 hours. They had been instructing from less than a year to 47 years with a mean of 10.65 years (SD = 11.57; median = 4.5 years flight instructing).

In Appendix I, Tables 8a and 8b also present the certificates and ratings held by the respondents, where they instruct, the types of syllabi they use and the numbers of students they have instructed during the preceding three years. Approximately half of the respondents (n = 212, 51.7%) indicated that they instruct part-time and 45.9% (n = 188) indicated that they are full-time instructors. Almost one-third (n = 125, 30.5%) indicated that they are trying to build flight time ("time-builders") to eventually secure some other type of employment as a pilot.

Amount of flight training experience and level of formal training (as determined by flight instructor ratings earned) were expected to play an important role in any differences found among the participants. A review of participants' numbers of hours of flight training given revealed a relatively normal distribution. Therefore the 20% of flight instructors who had the least amount of experience (20 to 270 hours of flight instruction given, n = 82) and the 20% of flight instructors who had the greatest amount of experience (2,300 to 15,000 hours of flight instruction given, n = 82) were selected for comparison in some of the analyses below. Additionally, individuals who indicated they had a CFI rating but not a CFII rating (certified flight instructor – instrument; n = 70, 17.1%) were compared at times with those who did have a CFII (n = 330, 80.5%). Unless a distinction is being made between CFIs and CFIIs in this report, the term CFI will be used generically to refer to all participants who completed the CFI Weather Training Survey.

Additionally, where or how an instructor taught (i.e., under FAR Part 61, under FAR Part 141) was thought to also play an important role in explaining differences in attitudes and approaches to covering weather during flight training. However, as many instructors teach in multiple places or under both Part 61 and Part 141, choosing how to divide them into discrete groups for the purpose of comparison was challenging.

On the surveys participants were presented with the following six options related to where they instructed and were told to "check all that apply": FBO (Part 61), Freelance (Part 61), Flight School (Part 141), Community College, University, or Other. Instruction provided under FAR Part 61 tends to be the least structured of the choices and CFIs are generally free to use a commercially available syllabus, a self-created syllabus, or even no syllabus at all. Occasionally they are required to use one developed by someone at an FBO where they are employed. Therefore, the emphasis given to weather instruction under Part 61 can vary widely from one instructor to the next.

Under FAR Part 141, a FAA-approved syllabus must be used. Therefore, weather instruction generally tends to be more structured and uniform under Part 141 than under Part 61. In principle, this means that greater emphasis may be given to weather instruction under Part 141 than by some instructors under Part 61. However, just because "weather" appears on a syllabus does not necessarily mean that CFIs instructing under Part 141 are teaching about it. Telling a

student to "Go read the chapter and watch the videotape" is a time-honored teaching technique among many CFIs, irrespective of where or under which FAR Part they teach. Likewise, quantity of instruction (or amount of emphasis) should not be confused with quality of instruction.

CFIs who instruct at universities or community colleges typically do so under Part 141 but some may instruct under Part 61. However, in the academic setting there is typically one or more quarter- or semester-long course(s) devoted to aviation meteorology and related weather topics. Thus, even though the instruction may occur under Part 141 or Part 61, students obtaining their flight training through an academic institution are often exposed to an even greater amount of weather instruction (at least on the ground) than students getting their training elsewhere.

For the purposes of some of the analyses described below, participants who indicated that they taught only at an FBO under Part 61 and/or only as a Freelance instructor under Part 61 were grouped together and identified as the Part 61 Only group (n = 160, 39.0%). Participants who indicated that they taught at a Flight School under Part 141 only were identified as the Part 141 Only group (n = 97, 23.7%). Likewise, respondents who indicated that they instructed only at a University and/or only at a Community College were identified as the Academia Only group (n = 20, 4.9%).

The difficulty with this grouping, however, is that CFIs who instruct in more than one place or under both Part 61 and Part 141 are not accounted for. Therefore, two other groups were identified. Instructors who instruct under Part 141 but not in an Academic setting were identified as the Part 141+ group (n = 152, 37.1%). This group included CFIs who taught only under Part 141 as well as those who taught under both Part 141 and Part 61. The thinking in putting these CFIs together was that those who teach under both Part 141 and Part 61 might be influenced by the structure and focus given to topics in their Part 141 employment when instructing students under Part 61. Thus, in their approach to teaching weather, it was thought that they might resemble the Part 141 Only group more than the Part 61 Only group. Analyses conducted to determine differences in the amount of emphasis given to the teaching of 34 weather topics by the Part 141+ group indicated that this was true.

T-tests indicated that a significant difference existed in the amount of emphasis given during flight training by the Part 141 Only and Part 141+ groups to just one weather topic: "Flight Watch and Enroute Weather" (t (169) = -2.10, $p < .05$). The Part 141 Only group obtained a mean rating of 2.75 on a 5-point Likert scale (SD = 1.29) indicating a greater degree of emphasis given to this topic compared to the Part 141+ group (M = 2.35, SD = 1.16).

In contrast, the Part 141+ group differed significantly from the Part 61 Only group in the amount of emphasis they gave to 14 of the 34 weather topics across all six of the weather categories except for Weather Interpretation. Participants in the Part 141+ group reported giving significantly greater emphasis to each of the 14 weather topics than participants in the Part 61 Only group did. Thus, support was found for the notion that instructors who teach under both Part 141 and Part 61 (but not in Academia) instruct all their students more like CFIs who instruct at flight schools under Part 141 Only than CFIs who instruct under Part 61 Only.

Using similar reasoning, instructors who taught in Academia but also taught at Part 141 Flight Schools and/or under Part 61 were grouped with the Academia Only group and labeled as the Academia ++ group (n = 79, 19.3%).

Because of the findings just described, when differences related to where or under which FAR Part instruction occurred were of interest in the analyses described below, the following groupings were used: Part 61 Only, Part 141+, and Academia++. (The plus sign in "Part 141+" connotes that these instructors may or may not also instruct under Part 61. The double plus sign in "Academia++" connotes that these instructors may or may not also instruct under Part 61 and/or Part 141.) Table 9 (in Appendix I) presents the number of CFIs and CFIIs in these groupings who also had Low and High amounts of Instruction Experience.

Emphasis Given to Weather Topics during Training

As mentioned above, in the first section of the survey CFIs were asked to indicate the total amount of training they provide to their student pilots, over the entire course of their training for the private pilot certificate, on 34 different weather topics. These topics were grouped into six different weather categories. Respondents indicated these amounts using a 5-point Likert scale with an additional answer option of N/A ("No training given by you on this topic") also available. Only points 1 and 5 were given text anchors: 1 = A little, approximately 1 to 30 minutes; 5 = A Great Deal, approximately 4-8 hours. It was believed that it would be quite difficult for CFIs to remember with any accuracy the specific amounts of time spent covering any one of these topics (e.g., Fog and Dewpoint, PIREPs, Handling Encounters with Hazardous Weather, etc.), particularly over the entire course of a student pilot's training. Therefore, few specific anchors were provided to elicit more of a "gut" impression on the part of the CFIs. Thus, indications about the amount of time or emphasis given to the various topics are best interpreted relative to each other rather than as absolutes.

Only the training CFIs provide during ground school or in-flight (including pre-flight briefings and post-flight debriefings) was of interest in this survey, not the amounts of time students spend in self-study reading texts and/or watching videos. In reviewing the results described below, it is important to keep in mind that instructors may place little relative emphasis on some topics not because they are seen as being unimportant but because it does not require a great deal of time to cover them thoroughly. For example, how to file, obtain, and use PIREPs may not require several hours of instruction.

Amount of emphasis frequency analyses indicated that over 30% of the participants spend only a little (approximately 30 minutes or less) or no time covering each of the following topics over the entire course of their primary students' training: "General Causes of Weather" (35.6%), "Temperature and Temperature Inversions" (36.1%), "Television Sources of Weather Information" (58.2%), "On-Field Computer Weather Stations" (41.3%), "Weather Radar and Charts" (31.9%), and "PIREPs" (32.9%). "Icing and Frost" is covered only a little or not at all by 27.8% of the participants and the "Practical and Psychological Factors Involved in Making a Go/No-Go Decision (e.g., "get-home-itis")" is covered only a little or not at all by 13.9% of the respondents.

Because the numbers comprising the rating scale might best be thought of as ordinal data rather than interval, non-parametric tests (i.e., Mann-Whitney U) as well as parametric tests (i.e., t-tests) were conducted and the results compared. The results regarding significant findings and significance levels were the same; therefore, the results of the parametric tests are reported here. Tables 10a and 10b (found in Appendix I) present the mean amount of emphasis placed on these topics by all participants as well as significant differences based upon instructor rating (CFI or CFII), amount of instruction experience (low or high) and how or where the participants instruct (Part 61 Only, Part 141+, or Academia++).

As can be seen in Table 10a, CFIs and CFIIs differ in the amount of emphasis they say they give to 17 of the 34 weather topics, particularly those found in two of the weather categories: Basic Causes of Weather and Weather Patterns, and Weather Hazards. In each case, the CFIIs place significantly greater emphasis on the topic than CFIs do. It is notable that CFIs and CFIIs did not differ significantly in the amount of emphasis they say they give to four topics regarding Weather-Related Decision Making.

Table 10a also indicates that participants with the lowest amount of instructing experience differed significantly from those with the highest levels of experience in the amount of emphasis they report giving to just two of the 34 weather topics: "Local Weather Conditions and Patterns" (t (162) = -2.95, $p < .01$), and "Icing and Frost" (t (160) = 2.16, $p < .05$). High experience instructors report that they place greater emphasis on these topics during training than low experience instructors do.

The results of ANOVAs presented in Table 10b indicate that that the amount of emphasis given to 30 of the 34 weather topics differs significantly according to how or where the participants instruct: Part 61 Only, Part 141+, or Academia++. Tukey post hoc analyses revealed that for the overwhelming majority of these 30 topics, participants in the Part 61 Only group reported that they place significantly less emphasis on them during training than participants in either the Part 141+ or Academia++ groups do. Only for the "Icing and Frost" topic did Part 141+ respondents differ significantly from the Academia++ respondents in their amounts of reported emphasis during training (F (2, 381) = 10.73, $p < .001$). Participants in the Academia++ group reported that they place significantly greater emphasis on this topic (M = 3.04, SD = 1.24) than either the Part 141+ group (M = 2.55, SD = 1.33) or the Part 61 Only group (M = 2.22, SD = 1.23) who did not differ significantly from each other.

Relative Emphasis Given to Weather Topics. Finally, the 34 weather topics were ordered according to the mean amount of emphasis given to each by the respondents and were reviewed based upon their rankings and relative distance from each other using standard deviations. As mentioned earlier, it is important to keep in mind that relatively less emphasis may be given to particular topics because they do not require several hours of instruction rather than because CFIs believe them to be unimportant.

Participants tend to place the least amount of relative emphasis on topics in the Basic Causes of Weather category and almost all of the topics in the Weather Services category including "PIREPs" and "Flight Watch and Enroute Weather." The topics in the Weather Services category that are given a greater degree of relative emphasis are "METARs and TAFs" and

"Flight Service Station Weather Briefings." Topics in the Weather Regulations category and in the Weather-Related Decision Making Category also generally received greater relative emphasis than topics in the other weather categories.

The relative emphasis given to a few other topics is worth mentioning. In the Weather Hazards category, "Icing and Frost," "Turbulence," and "Windshear and Microbursts" tend to receive less emphasis whereas "Wind and Crosswinds" tends to receive quite a bit more, relatively speaking. Although most topics in the Basic Causes of Weather category tend to receive relatively less emphasis, participants did report giving greater emphasis to the "Clouds and Ceilings" topic as well as the "Local Weather Conditions and Patterns" topic. Interestingly, the "Predicting Weather Conditions" topic tends to receive relatively less emphasis whereas the "Applying Weather Information in Flight Planning" reportedly receives quite a bit more – as much as topics within the Weather Regulations and Weather-Related Decision Making categories.

Weather Categories

The means and standard deviations for the amount of emphasis given to the six different weather categories during instruction were obtained by aggregating across all weather topics within each category and are presented in Tables 10a and 10b in Appendix I. Participants were not asked to rate the amount of emphasis they give to the weather categories during training – just the individual weather topics that comprise the six categories. In a separate section of the survey, participants were, however, asked to rank order the categories according to the importance they feel each category has for the training of student pilots (1 = most important and 6 = least important). The Friedman Test for Related Samples was performed and it was found that significant differences existed in the category rankings ($n = 409$; $X^2 (5) = 554.95$, $p < .001$). The following ranking of the categories (from most important to least) was obtained: 1. Weather-Related Decision Making, 2. Weather Hazards, 3. Weather Interpretation, 4. Weather Services, 5. Weather Regulations, 6. Basic Causes of Weather.

However, ranking of the weather category emphasis means (as determined by aggregating across the emphasis ratings given to the weather topics within each category) was as follows: 1. Weather Regulations, 2. Weather-Related Decision Making, 3. Weather Interpretation, 4. Weather Hazards, 5. Weather Services, 6. Basic Causes of Weather. Thus, although participants indicated that Weather-Related Decision Making was the most important category, the amount of emphasis they report actually giving weather topics indicates that Weather Regulations is the category that receives the greatest amount of emphasis during training; note that Weather Regulations was ranked fifth in importance of the six categories. Similarly, although participants ranked Weather Hazards as second most important, this category really receives less actual emphasis (it was fourth) as determined by the amount of emphasis CFIs said they give to topics in this category.

Instruction of Weather during Ground School and In-Flight

Participants were also asked to indicate the amount of time they spend instructing about weather during both ground school and in-flight ("in-flight" includes pre-flight briefings and post-flight debriefings in addition to instruction that occurs while actually flying). Participants were directed to make these estimations for their work with primary student pilots who had had no previous training.

As can be seen in Table 11 (found in Appendix I) quite a range of hours were given and some are a bit suspect (for example, the 30, 40, or 50 hours of in-flight weather instruction that were reported). Some of the equally high or higher hours some CFIs reported covering weather during ground school may also be suspect. It is possible, of course, that the respondents in question teach aviation meteorology courses or ground school classes and indicated the amount of time spent teaching the entire course rather than just that time devoted to weather topics. In any event, the median numbers of hours reported are probably the most appropriate measure of central tendency to examine. In doing so one can see that the participants, regardless of their level of instructor rating, level of experience, or where/under which FAR Part they instruct, tend to spend five to six hours on weather during ground school with their primary student pilots and five to six hours on weather instruction in-flight.

CFI Mastery of Weather Content and Quality of Instruction

As described earlier, CFIs were asked to rate the degree of confidence they had in their own mastery of content contained in the six different weather categories using a 5-point Likert scale where1 was a "No Confidence" rating and 5 was a rating of "Extremely Confident." Similarly, participants were asked to indicate, as honestly as they could, the quality of the instruction they provide to their student pilots in the same six weather categories using the following scale: N/A = no instruction, 1 = Very Poor, 2 = Poor, 3 = Adequate, 4 = Good, 5 = Very Good. Tables 12a-12d (located in Appendix I) present the mean mastery and quality ratings and standard deviations for all participants (Table 12a) and participants broken down into various groupings according to their level of instructor rating (Table 12b), where or under which FAR Part the participants instruct (Table 12c), and low or high level of instructing experience (Table 12d).

All participants generally reported feeling very confident of their own mastery of the content in all six weather categories (see Table 12a). Although participants rated the quality of the weather instruction they provide to be Adequate to Good, these quality ratings were significantly lower than their reported mastery for each category. For example, respondents' mean mastery rating of content in the Basic Causes of Weather category was 3.69 (SD = .75), which was significantly higher than their rating of the quality of instruction they provide regarding the Basic Causes of Weather (M = 3.33, SD = .95; t (408) = 8.92, p < .001). This pattern was evident for each of the six weather categories indicating that participants believe that their knowledge and understanding of weather information, in all six of the categories, is significantly better than their ability to teach it to their students.

This was also found when participants were grouped according to instructor rating level, but interestingly, more for CFIIs than for CFIs (see Table 12b). Additionally, CFIs and CFIIs differed significantly in their reported mastery of content regarding Weather Hazards (t (397) = -1.99, p < .05) and Weather Regulations (t (398) = -3.15, p < .01). In both cases, CFIs rated their mastery significantly lower than CFIIs rated theirs (Weather Hazards: CFI: M = 3.89, SD = .67; CFII: M = 4.07, SD = .70. Weather Regulations: CFI: M = 3.87, SD = .88; CFII: M = 4.19, SD = .75). Similarly, CFIs and CFIIs differed significantly in their reported quality of instruction related to Weather Hazards (t (397) = -2.51, p < .05), Weather Services (t (396) = -2.02, p < .05), and Weather Interpretation (t (90.9) = -2.54, p < .05). Again, CFIs rated the quality of instruction they provide in these categories significantly lower than CFIIs do (Weather Hazards:

CFI: M = 3.70, SD = .84; CFII: M = 3.96, SD = .79. Weather Services: CFI: M = 3.77, SD = .95; CFII: M = 4.00, SD = .84. Weather Interpretation: CFI: M = 3.44, SD = 1.00; CFII: M = 3.77, SD = .84). Significant differences were also found between the quality of instruction ratings given by low experienced and high experienced CFIs related to several of the weather categories (see Table 12d in Appendix I).

The disparity between mastery of weather content ratings and quality of weather instruction ratings is also evident in the results presented in Table 12c (see Appendix I). Participants in the Part 141+ group rated their mastery of weather information significantly higher than the quality of the instruction they provide in all six of the weather categories. Similarly, mastery of weather information ratings made by participants in the Academia++ group in four of the six weather categories were significantly higher than their related quality of instruction ratings. Interestingly, only for the Basic Causes of Weather category were the mean mastery ratings given by participants in the Part 61 Only group significantly higher than their quality of instruction ratings (t (159) = 5.68, $p < .001$. Mastery: M = 3.74, SD =.75; Quality: M = 3.41, SD = .84).

Another finding of interest evident in Table 12c is that for only one category (Weather Regulations) did the three groups differ from each other significantly in their mastery of weather content ratings (F (2, 223.8) = 3.68, $p < .05$). Tukey post hoc analyses revealed that participants in the Part 61 Only group rated their mastery of Weather Regulations (M = 4.08, SD = .78) significantly lower than did participants in the Academia++ group (M = 4.35, SD = .70). Thus, where or under which FAR Part a CFI instructs appears to have little bearing on the mastery CFIs feel that they have of weather information or on the quality of instruction they believe they provide.

Taking Students into Marginal Weather Conditions during Training

In the fourth section of the survey, participants were presented with the following:

> "There is some debate among CFIs with regard to exposing student pilots to marginal weather conditions. Some feel it is best to take students pilots up into less than ideal weather conditions so the student will understand what flying in poor conditions is really like, and therefore, will be less likely to go up in such conditions on their own. Others feel that exposing students to such conditions may make them feel more confident in their ability to handle those situations, and therefore, they will be more likely to attempt flight into marginal weather."

Participants were then presented with a 7-point Likert scale, ranging from –3 (Strongly Against) to +3 (Strongly For) with 0 as a Neutral position, and were asked to rate their stance on taking students pilots into marginal weather conditions. Almost two-thirds of the participants (n = 262, 63.9%) selected a +2 or +3 rating; only 16.8% (n = 69) selected a neutral (0) or negative rating (-3, -2, or -1).

The mean attitude rating for all participants was 1.61 (SD = 1.45) with a median rating of 2. The attitude ratings of CFIs did not differ significantly from those of CFIIs (t (398) = -.29, p = .77) nor did the attitudes of low experience instructors differ significantly from those of high experience instructors (t (162) = -.47, p = .64). However, participants in the Part 61 Only group

expressed a significantly more favorable mean attitude toward taking students into marginal conditions during training (M = 1.97, SD = 1.28) than participants in the Academia++ group did (M = 1.22, SD = 1.59; F (2, 388) = 8.93, p < .001). Likewise, Tukey post hoc analyses revealed that the mean attitude expressed by the Part 61 Only group was significantly more favorable (p < .01) than that expressed by participants in the Part 141+ group (M = 1.45, SD = 1.51).

In addition to gathering information about participants' attitudes regarding exposing student pilots to marginal weather during training, participants were also asked if they had actually ever done so and if so, how many times. Slightly over four-fifths of the participants (n = 331, 80.7%) indicated that they had indeed taken students into marginal conditions. A Chi-Square analysis indicated that a significantly greater percentage of CFIIs (n = 279, 84.8%) did so compared to CFIs (n = 46, 65.7%; X^2 (1) = 13.92, p < .001). Similarly, a significantly greater percentage of high experience instructors reported having taken students into marginal conditions (n = 72, 87.8%) compared to low experience instructors (n = 54, 65.9%; X^2 (1) = 11.10, p < .01). And, a third Chi-Square analysis revealed significant differences between the percentages of instructors in the Part 61 Only (n = 140, 88.1%), Part 141+ (n = 114, 75.0%), and Academia++ (n = 62, 78.5%) groups who exposed their students to marginal conditions (X^2 (2) = 9.03, p < .05). The mean number of times that all participants, who report taking their students into marginal weather, did so was 2.12 (SD = 2.14, Median = 2).

Finally, participants, who indicated that they have taken student pilots into marginal weather conditions during training, were asked to indicate the kind of conditions they went into. Marginal conditions are normally thought of those related to reductions in visibilities or ceiling levels – those conditions that distinguish visual meteorological conditions (VMC) from instrument meteorological conditions (IMC). The most popular method used by participants to expose students to these types of marginal conditions was to file an IFR flight plan and take their students along on an instrument flight in true IMC (n = 198, 59.8%). The second most poplar method was to purposefully fly with students into areas of low visibility (how low was not specified; n = 186, 56.2%). Participants also reported that they had flown with students with a Special VFR clearance in SVFR weather conditions (n = 179, 54.1%) or had flown close to clouds with students (how close was not specified; n = 168, 50.8%). Many participants also indicated that they had purposefully flown into clouds with students (n = 104, 31.4%) even though doing so without an IFR clearance is a violation of the FARs. Although it is not typically considered a type of marginal weather condition, an overwhelming majority of participants indicated that they had made a point of flying with students when it was quite windy or turbulent (n = 309, 93.4%).

Discussion

Data Collection Strategy

Although it was not the primary purpose of this project, when the study was initially proposed it was hoped that the data collection strategy would allow for a comparison of mail surveys and on-line surveys as methods for collecting data from the pilot population, or more specifically in this case, certified flight instructors. These analyses were to be used to help determine if an on-line

data collection method would yield similar results (and tap into the same population) as the more traditional mail survey method.

Unfortunately, due to practical and logistical considerations the data collection strategy had to be modified somewhat. In particular, notices, which identified the two ways in which pilots could complete the survey – on-line or to request a paper-pencil version, were planned for placement in both the NAFI Monitor as well as the NAFI e-Monitor. Unfortunately, the notice in the paper NAFI Monitor never appeared. Thus, only the e-Monitor carried the notice about the survey and, since it is a Internet-based newsletter, it is not surprising that the vast majority of participants responding to this notice chose to complete the Internet-based version of the survey rather than request a paper-pencil copy. Additionally, paper-pencil versions of the survey were not distributed to CFIs during AOPA CFI re-certification workshops, as had originally been planned, but a notice about the survey, with its on-line web address, did appear on the AOPA website, which was not originally planned. As a consequence, almost all of the instructors who completed a paper-pencil version of the survey did so through the solicitation of Part 141 flight schools and training centers.

CFIs who instruct at Part 141 flight schools tend to be younger, compared to CFIs instructing other places, as they are often working on building up flight experience in the hopes of securing future employment with charter, regional, or national air carriers. They tend to work as full-time instructors and, thus, it is not illogical to expect them to work with a greater number of students per year than part-time instructors do. These observations about the nature of instructors and instruction at Part 141 schools account for all the significant differences that were found between the participants who completed the paper-pencil survey and those who completed it on-line. Therefore, this study does not help to answer the question: Is it possible to tap into the same pilot or instructor population on-line as it is by using the more traditional mail method?

The CFI Weather Training Survey

It is important that readers remember that all findings are based upon the results of a self-report survey. Although an effort was made to eliminate those participants who might have responded with an extremely biased response set, all data from self-report surveys reflect the various biases of the participants and do not necessarily match with reality. In other words, an instructor who indicated that he has an average mastery of information related to the Basic Causes of Weather and Weather Patterns may actually have very poor mastery or very good mastery of this information. Readers are also cautioned not to confuse reported quantity (or amount of emphasis given to a topic during instruction) with quality of instruction. It is possible for an instructor to spend a great deal of time instructing on topic but to do so very poorly.

The findings related to the amount of relative emphasis participants report giving to 34 weather topics within six weather categories during training are rather contradictory. Participants indicated that they tend to spend around 10 – 12 hours instructing primary student pilots about weather. No differences in this overall amount of time spent were found related to level of instructor rating, amount of instructing experience, or where/under which FAR Part the participants instruct. However, when presented with the 34 individual topics, CFIIs indicated that they place a significantly greater emphasis than CFIs on a full 50% of the topics. Similarly, participants who instruct only under FAR Part 61 report that they place significantly less

emphasis on almost all of the weather topics than participants who instruct under FAR Part 141 and/or in academic settings. There are few significant differences between instructors with lower and higher amounts of instructing experience in terms of the emphases they place on these topics; this finding is rather unexpected.

Although participants were asked about the instruction they give to primary student pilots (i.e., those who are working to obtain private pilot certificates), it is possible that CFIIs responded regarding the instruction they provide to all students, including their instrument students. Weather is typically emphasized a great deal more during instrument training than during primary training. However, it might also be possible that the emphasis CFIIs give to weather topics in their work with instrument students carries over into their work with primary student pilots. Recall that it was found that participants who instruct under both Part 141 and Part 61 share greater similarities with participants who instruct under Part 141 only than those who instruct under Part 61 only (in terms of emphasis given to weather topics). Hence, their approach to instructing their Part 61 students is likely rather similar to their approach in teaching their Part 141 students. In an analogous way, CFIIs may approach the weather training of their primary students somewhat similarly to the way they approach this training with their instrument students.

Participants who only instruct under Part 61 have greater flexibility regarding their approach to instructing all topics when compared to the greater structure imposed upon those instructing under Part 141 and/or in academia. This might, at least in part, explain the significantly lesser emphasis they report placing on an overwhelming majority of the weather topics compared to their colleagues instructing under Part 141 and/or in academic settings.

The emphasis given to the four topics that comprise the Weather-Related Decision Making category were of particular interest. Because of the high fatality rate associated with many GA accidents where poor weather conditions were a factor and the continuing problem of VFR flight into IMC, many in the GA community believe that weather-related decision making should be stressed heavily during primary training. Although CFIs and CFIIs as well as low and high experience instructors did not differ significantly in the amount of emphasis they report giving to the four Weather-Related Decision Making topics, instructors who instruct under Part 141 and/or in academia do emphasize the majority of these topics to a significantly greater degree than those who instruct under Part 61 only.

In addition to examining differences between groups of CFIs with regard to the emphasis they give to the various weather topics, the importance of the topics relative to each other was also of interest. By rank ordering the emphasis ratings given to the topics by the participants, it was found that, generally, Basic Causes of Weather and Weather Services topics are given less emphasis during training than topics pertaining to Weather Regulations and Weather-Related Decision Making. Some exceptions to this are that METARs and TAFs and Flight Service Station Weather Briefings (from the Weather Services category), and Clouds and Ceilings and Local Weather Conditions and Patterns (from the Basic Causes of Weather category) tend to be emphasized to a relatively high degree by participants.

Flight Watch and Enroute Weather was one of the Weather Services topics that received a relatively low ranking. It may have received this lower ranking because instructors feel that they are able to thoroughly cover the use of enroute weather services in a fairly short amount of time. Or, conversely, instructors may feel that this service is relatively less important or believe that students can learn about it sufficiently on their own. However, given the continued problem of pilots flying under VFR into IMC, instructors should be encouraged to take it upon themselves to instruct their students about this service and to demonstrate using it when conducting all dual cross-country flights.

Although participants indicated that Weather-Related Decision Making was the category of information that had the greatest importance for training student pilots, it was found that they actually report giving more emphasis to Weather Regulations during training. It is possible that this finding is related to the fairly great difficulty many instructors report having regarding teaching and assessing weather-related decision making (Burian, 1999) in combination with some instructors having somewhat heightened legalistic concerns related to retaining one's flying privileges. CFIs also appear to be under the misperception that they place a greater emphasis covering various weather hazards than they actually do during training.

Some compelling findings were discovered related to participants' ratings of their mastery of weather content and the quality of the weather instruction they provide. The first was that all participants, irrespective of where or under which FAR Part they instruct, feel similarly confident about the mastery they have of weather material and the quality of the weather instruction they provide. However, all participants believe that their knowledge and understanding of weather information is significantly better than their ability to teach it to their students. To the degree that this is so, CFIs might find it particularly helpful to learn more techniques and better methods for teaching weather topics during their initial CFI training and re-certification.

A very large percentage of the participants support the practice of taking students into marginal weather conditions during training, and slightly over 80% reported that they have done so an average of approximately 2 times over the course of each of their students' training. Participants who only instruct under Part 61 were significantly stronger advocates for this practice and actually reported providing their students with this experience significantly more often than their colleagues who instruct under Part 141 and/or in academia.

Although CFIs and CFIIs were equally strong supporters of this practice, CFIIs reported that they actually take their students into marginal conditions significantly more often than CFIs do. Similarly, high experience instructors report exposing their students to marginal conditions significantly more often than low experience instructors do, even though the two groups do not differ in their strong advocacy for doing so. It is possible that CFIIs and high experience instructors have a greater degree of comfort and personal experience in dealing with such conditions than their counterparts do, which is reflected in these findings.

Some instructors believe that, by exposing their primary students to marginal conditions during training, their students will safely learn how treacherous such conditions can be and will, as a consequence, be more likely to avoid them in the future (Burian, 1999). However, in a survey of

recently certificated private pilots who reported having flown in marginal weather with their CFIs during training, it was found that 21.7% (n = 15) felt more confident of their ability to fly in similar conditions on their own and would actually feel comfortable in doing so (Burian, 1999). A greater number (68.1%, n = 47) indicated that although they felt more confident in their ability to fly in marginal weather on their own, they would not feel comfortable in doing so. The relationships between exposure to and experience with such conditions, the actual kinds of marginal weather in which the flight(s) occur, the instructional approach taken by the CFI, and student personality variables, including comfort levels, are not well understood. Nonetheless, the results from this earlier study indicate that the lesson CFIs are attempting to teach may actually be backfiring for at least some of their students. This is clearly an issue that demands greater discussion and exploration.

Although Certified Flight Instructors, as a group, believe that they have a solid mastery of weather information that is important for safe flight operations, the findings in this study do not generally support this contention. However, none of the pilots in this study, even those with the greatest amounts of experience or training, demonstrated a strong mastery of the weather material. Although they certainly have a role, CFIs alone should not bear the blame for the state of impoverished weather knowledge demonstrated by the participants in this study. Pilots, themselves, must take responsibility to learn about weather during training. They must work with their CFIs to actually learn the material – not just what they will need to know to pass the written test. CFIs should not leave it up to the student to acquire all weather information on their own, nor should students leave it up to the CFIs to "spoon-feed" them everything about the weather that they will need to know. Certificated pilots must make a concerted effort to refresh their weather knowledge regularly; making sure that weather is taught comprehensively at all levels of instruction and during recurrent training would help. This is especially important given that pilots do not seem to gain operationally relevant weather knowledge in a systematic way through experience alone – formal training is necessary for this to occur.

Strangely, very few differences are reported to exist between CFIs related to the amounts of experience they have in instructing. However, instructors with higher levels of instructor ratings (i.e., CFII) and those who are required to teach in more structured ways (i.e., under Part 141 or in academia) do appear to differ from their colleagues in the weather instruction they provide. Further exploration is needed to determine if these reported differences do indeed exist and, if so, how they might relate to instruction quality and student learning.

CFIs acknowledge that the quality of the weather instruction they provide is not at the same level as their own knowledge of the information. CFIs may need better support, materials, and methods to use to assist them in improving the weather training they give to their students (OFCM, 2002). There is much that the FAA could also do to assist. Weather questions on the FAA Private Pilot Written Examination could tap into a broader range of weather topics, particularly weather-related decision making, and could focus better on weather knowledge and skills that are operationally relevant. In particular, questions are needed that require applicants to integrate their weather knowledge across several different areas, interpret the information they are given, and demonstrate an understanding of the implications that information has for real flight operations. Various weather services and products could be made more "user friendly" (Joint Action Group for Aviation Weather, 1999) by doing away with unneeded abbreviations. Likewise, unnecessary redundancies between the various products could be eliminated. Weather regulations that are inconsistent without reason could also be changed; inconsistencies that are necessary could be supported with those rationales to improve pilot comprehension and retention.

All members of the aviation community bear responsibility for improving the state of pilot weather training and increasing the level of pilot weather knowledge and understanding. Only if we each do so can we improve the state of general aviation safety related to weather.

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