

Comparing Reported Safety Behavior of Safety Major Aviation Students and Non Safety Major Aviation Students



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Abstract

Safety behavior is an essential quality for people directly involved in safety sensitive industries like Aviation. The inputs to aviation safety programs like Aviation Safety Action Program (ASAP) and Aviation Safety Reporting Systems (ASRS) come from voluntary reports of pilots, controllers, maintenance technicians, and others. The study attempts to determine the difference in safety behavior of students in safety major and students in non safety major. The purpose of the study is to determine if safety education improves students' safety behavior. The self-selected participants in this research design completed a five point scale survey. Their responses towards factors like safety priority i.e., while engaging in activities involving risks, safety activity i.e., exercising safety in everyday activities, and safety awareness i.e., ability to identify/locate a hazard were collected. A two-independent samples t-test showed that the survey scores of students in safety major was significantly higher than the survey scores of students in non-safety majors. The results indicated that students in safety major reported significantly higher safety behavior compared to students in non-safety major.

Keywords: Safety education; Safety behavior; Safety survey; Statistical analysis; Aviation safety

Abbreviations: ASAP: Aviation Safety Action Program; ASRS: Aviation Safety Reporting Systems; VDRP: Voluntary Disclosure Reporting Program; ASAP: Aviation Safety Action Program; FOQA: Flight Operations Quality Assurance; LOSA: Line Operations Self Audit; FAA: Federal Aviation Administration; IFALPA: International Federation of Airline Pilots Association; SSBS: Safety Behavior Scale; RBS: Risk Behavior Scale

Introduction

Commercial air transportation recorded the lowest accident rate in 2015 over the past few years. The global aviation accident rate involving scheduled commercial operations was 3.2, 2.9, 3.0, and 2.8 accidents per million departures in 2012, 2013, 2014, and 2015 respectively [1]. This result may be attributed to the industry's safety programs like Voluntary Disclosure Reporting Program (VDRP), Aviation Safety Action Program (ASAP), Flight Operations Quality Assurance (FOQA), and Line Operations Self Audit (LOSA). Among all the safety programs, VDRP and ASAP are the programs that encourage airline employees to report on issues like, but not limited to, hazards in workplace, errors in operations, violation of established policies and procedures, and suggestions to improve safety.

With an increasing number of airlines and airports implementing voluntary reporting programs, the dependence on employees for safety reports is increasing. Unless the employees

have a strong understanding of hazards, associated risks, ways to mitigate the risks, and safe operating practices, the contribution to voluntary safety reporting may be minimal. However, safety education may influence a person's safety behavior. This study attempts to determine if safety education is related to safety behavior of students in the College of Aviation at Embry-Riddle Aeronautical University, Florida, USA.

Review of Relevant Literature

Background Information

On December 1, 1974, Trans World Airlines flight 514 crashed in Mount Weather, Virginia, while in-route to Washington Dulles International Airport killing all 85 passengers and seven crewmembers on board. The flight was diverted from landing at Washington National Airport (DCA) to Washington Dulles International Airport (IAD) due to high crosswinds on the runway

at Washington National Airport. The aircraft, while on the final approach segment, encountered heavy downdrafts, causing very high altitude deviations. The aircraft later impacted the west slope of Mount Weather. It was discovered later in the investigation that a United Airlines flight escaped from a similar disaster on the same approach and the same location six weeks prior.

Pilots reported the incident to United Flight Operations, but the information was never communicated to the Federal Aviation Administration (FAA) [2]. The TWA Flight 514 accident brought significant changes to aviation safety. The FAA realized that it is not possible to have a law enforcement officer on every corner and an informer in every airline [2]. This realization laid the foundation for development of voluntary safety programs like ASAP and VDRP. The safety programs such as ASAP, VDRP, FOQA, LOSA and the systematic approach called Safety Management System (SMS) covering these programs have substantially helped foster safety in aviation. The FAA's "Voluntary reporting programs have significantly contributed to the nation's impressive commercial aviation safety record, including improvements to training as well as enhanced operational and maintenance procedures" [3].

However, aviation is a high-risk industry. The severity of a single commercial aviation accident can be phenomenal. In its Accident Analysis & Prevention Briefing Leaflet, the International Federation of Airline Pilots Association (IFALPA) mentioned that the current positive safety statistics can be improved only by continuously and meticulously managing the risks correctly [4]. Encouraging more employees to report errors in operations, violation of regulations, unsafe practices, and safety concerns is one way to increase the effectiveness of voluntary safety programs. Increasing employee participation in voluntary safety programs can tremendously enhance aviation safety as the ASAP data identifies safety concerns that are otherwise unobtainable [5].

However, the challenges of using, and advancing voluntary safety programs, are many. In its report to Congress, the FAA mentioned that minimum involvement from employees in such programs was one of the few challenges that airlines were struggling with [6]. Although the reason behind minimal participation of employees in voluntary safety programs can be many, such as labor union disagreement, negative view of the program etc. as stated in FAA's report to Congress [6], a contributing factor could be the diverse safety behavior of people.

Factors Influencing Safety Behavior

Multiple factors can influence the safety behavior of humans. Goh and Sa'adon (2015) mentioned that factors like intention, subjective norm, attitude, and perceived behavioral control can influence a person's safety behavior [7]. Jitwasinkul and Hadikusumo (2011) conducted semi-structured interviews of employees and reviewed documents of a construction company and identified seven organizational factors that could

influence safety behavior: Communication, Culture, Management commitment, Leadership, Organization learning, Empowerment, and Reward system [8]. Tappura, Nenonen, and Kivisto-Rahnasto (2017) conducted a study on managers working at different industrial organizations and identified that role overload, production demands, overly formal safety procedures, external safety goals, workforce attitudes and managers' attitudes can influence managers' commitment to safety [9]. Zhong, Huang, and Wu (2017) also identified that higher work experience and varying knowledge had significant impact on the safety related behavior of pig farmers in China [10].

Safety Education and Safety Behavior

With so many factors influencing the safety behavior of humans, safety behavior of a person may not remain consistent. However, safety education may have the potential to develop a consistent safety behavior in humans. Previous studies have shown that education improves awareness in people. For example, cabin safety education has positively affected airline passenger cabin safety knowledge and attitude [11]. Savage (2006) found that educational activities have a measurable effect on improving the safety behavior of people [12]. Moreover, studies have also shown that educating students on courses that teach risk identification, evaluation, and mitigation has improved the safety knowledge of students. Assessment techniques like zero tolerance assessment and 360-degree feedback focused towards concepts of risk management and safety culture have improved the attitude of students towards knowledge of health and safety risk management [13].

Kim et al. (2012) found that food safety education to middle school students showed significant progress in hand hygiene behavior and food safety knowledge [14]. Canders (2014) mentioned that, "Collegiate aviation students properly indoctrinated in a safety culture through learning management systems may provide the raw material from which airlines can build the future safety cultures necessary to assure safe global airline operations" [15]. With previous studies showing safety education improves safety attitude and knowledge of participants, this study attempted to determine if safety education is related to safety behavior of students. It attempted to see if students educated in safety demonstrate safety behavior or practice safety in their routine daily activities.

Methodology

Safety behavior of students was measured through a survey by examining some factors adapted from a study of Williamson, Feyer, Cairns, and Biancotti [16]. (Table 1) provides more information about the factors, which are safety awareness, safety priority, and safety activity. An original survey, the Student Safety Behavior Scale (SSBS) was developed with qualitative and quantitative questions to analyze the safety behavior of participants. SSBS was based on a 5-point scale and only extreme poles were labeled

making it a rating scale. Each question was designed to represent one or more of the three safety factors listed in (Table 1). Another survey called the Risk Behavior Scale (RBS) developed by Weber, Blais, and Betz [17] was also administered. The RBS containing 40

questions was a 5-point scale with all the poles labeled making it a ranking scale. It was used by Weber et al. (2002) to analyze the risk behavior of students in investment, ethical, gambling, health, recreational, and social activities.

Table 1: Factors Included in the Survey Design and Their Operational Definitions.

SI No.	Factor	Operational Definition
1	Safety Awareness	Ability to identify hazards and risks.
2	Safety Priority	Beliefs about importance of safety in his/her activities involving high risk.
3	Safety Activity	Perceptions of the individual's own safe behavior.

Research Approach

The study was a quantitative and qualitative, performed through an online survey. The RBS was administered along with the SSBS to avoid any response bias upon administration of only SSBS and also to identify any correlation between safety behavior measured by SSBS and other risk behaviors measured by RBS. The study hypothesized the following:

H1: There is no difference between self-reported safety behavior of students in the safety major and the self-reported safety behavior of students in a non-safety major.

H2: There is no difference between self-reported safety behaviors of students enrolled in different non-safety majors.

H3: There is no relationship between self-reported safety behavior and the number of safety classes taken.

H4: There is no relationship between self-reported safety behavior and risk behavior in investment, gambling, ethical, health, recreational and social behavior.

Procedure

The study was a non-experimental survey design. This study was approved by the Institutional Review Board (IRB) at Embry-Riddle Aeronautical University. Participants took a demographic questionnaire and two surveys. Questions requiring quantitative and qualitative responses were asked. Participants accessed the survey using the URL provided to them through a computer or smart phone of their choice and at their convenient time. The first page of the survey was the Informed Consent page. Participants were asked to answer demographic questions in the next page. After answering demographic questions, participants completed the RBS administered from Weber et al. (2002).

After RBS, participants completed the SSBS. Care was taken to ensure confidentiality of the information provided by participants as only the researcher had secure access to the account on the online website used to administer the survey. At no point in the survey were the participants asked for their names or any other

identifying information. In addition to that, all the participants were assigned participant numbers by the online survey platform and were referred to using their respective participant numbers. Survey Monkey, an online platform to conduct surveys, was used to collect data for the study. Eleven demographic questions, the RBS, and the SSBS was designed in the online survey platform. Survey Monkey could store the quantitative and qualitative responses from the participants securely to which only the researcher had access. The data was then migrated to Microsoft Excel for organization and later transferred to IBM SPSS for data analyses.

Population/Sample

The sample for the study comprised 149 students from the College of Aviation at Embry-Riddle Aeronautical University. All the participants for the study were self-selected. The researcher sent out an email asking for participation to all the students pursuing bachelor's degrees in College of Aviation through respective email distribution groups. The researcher also posted advertisements on the notice boards asking for participation.

Descriptive Statistics

Of the 211 participants who initiated the survey, only 149 completed both the RBS and SSBS. Fifty-three responses were from students who either majored in safety or had taken safety coursework. Ninety-six responses were from students who neither majored in safety nor had taken any safety coursework. The number of male and female students who completed the survey were 109 and 38 respectively. Two participants preferred not to provide their gender. A good representation of all the four college years was observed in the study. The sample had 19.5% freshmen year participants, 25.5% sophomore year participants, 22.15% junior year participants, and 32.88% senior year participants. Participants were also a good representation of different bachelor programs offered at the College of Aviation in Embry-Riddle Aeronautical University. Out of the 149 participants, 85 participants are part of the Aeronautical Science major. (Table 2) shows the list of bachelor degree programs and respective number of participants from each program.

Table 2: Number of Participants and their Respective Bachelor Degree Programs.

SI No.	Bachelor Program	No. of Participants	Target Population
1	Aeronautical Science (AS)	85	1266
2	Unmanned Aircraft Systems (UAS)	21	216
3	Aeronautics	18	231
4	Air Traffic Management (ATM)	11	116
5	Aerospace and Occupational safety (AOS)	7	59
6	Aircraft Maintenance Sciences (AMS)	6	236
7	Aviation Meteorology	1	63

Results

Reliability Testing

Cronbach’s α was used to calculate the reliability of the survey i.e. the internal consistency of the instrument by analyzing the responses to questions eliciting a particular behavior. Cronbach’s α obtained for SSBS survey was 0.67. In general, a Cronbach’s α of 0.70 is acceptable for survey rating scale [18] and even Churchill recommended that a Cronbach’s α of 0.60 or higher is acceptable for basic research [19].

Hypothesis Testing

Two independent samples t-test H1: The null hypothesis

was that there is no difference in safety behavior of students in the safety major (bachelor’s degree in aerospace and Occupational Safety) and the safety behavior of students in a non-safety major (all other bachelor degree programs mentioned in (Table 3)). The grand mean SSBS score of all 149 responses was obtained ($M = 64.32, SD = 7.63$). The mean SSBS score of students in safety majors ($M = 70.29, SD = 5.47$) was higher than the mean SSBS score of students in non-safety majors ($M = 64.02, SD = 7.61$). The assumption of equality of variance was tested. Levene’s test for equality of variance was not significant, at $p = .05$. Hence, equal variances were assumed. A two-independent samples t-test was significant, $t(147) = 2.15, p = .033$. Cohen’s $d = .95$.

Table 3: Comparison of Mean Scores between Different Majors.

	AOS	AS	Aeronautics	UAS	ATM	AMS
AOS		n	n	*	*	*
AS			n	n	*	n
Aeronautics				n	n	n
UAS					n	n
ATM						n
AMS						

Table Abbreviations: AOS: Aerospace and Occupational Safety; AS: Aeronautical Science; UAS: Unmanned Aircraft Systems; ATM: Air Traffic Management; AMS: Aircraft Maintenance Sciences

Note * = significance ($p < .05$); n = non-significant.

One-way between subjects ANOVA : To get a better understanding of how SSBS scores of students with safety majors differed from the SSBS scores of students in remaining majors, a one-way between subjects ANOVA was run. Meteorology major was omitted as it had only one participant. One-way between subjects ANOVA was significant, $F(5, 142) = 2.426, p = .038, \eta^2 = .079$. Post hoc tests were conducted between every major. Aerospace and Occupational Safety major scores were significantly higher than Unmanned Aircraft Systems majors, Air Traffic Management majors, and Aircraft Maintenance Science major (see (Table 3) for additional differences between groups) [20].

Correlation between safety behavior and number of safety classes taken: The null hypothesis was there is no relationship between safety behavior and number of safety classes taken. A two-tailed Pearson's correlation was run. There was no significant correlation between SSBS scores and number of safety classes taken.

Correlation between SSBS, RBS, and each factor in RBS: The null hypothesis was there is no relationship between safety behavior analyzed in the SSBS and risk behaviors in investment, recreational, health, ethical, social, and gambling activities analyzed in RBS. A Spearman Rho correlation was run as the RBS was a ranking scale in which all poles were labeled and SSBS was a rating scale in which only extreme poles were labeled. There was a significant negative correlation between safety behavior in SSBS and total risk behavior in RBS, $r(147) = -.304, p < .001$. Three other significant negative correlations were observed - between safety behavior and gambling risk behavior, $r(147) = -.188, p = .002$, between safety behavior and health risk behavior, $r(147) = -.386, p < .001$, and between safety behavior and ethical risk behavior, $r(147) = -.291, p < .001$.

Qualitative Data

All the participants were asked if they were interested in sky diving, bungee jumping, and what would they investigate about either of the activities before doing them if they were interested. Participants who mentioned they were interested in neither of the activities were asked what they would recommend their friends to investigate about those activities before their friends did them. One hundred and twenty one participants mentioned that they were interested in sky diving. Twenty-eight participants mentioned they were not interested in sky diving. Seventy-five participants mentioned that they would investigate about/recommend their friends to investigate about safety related factors like safety instructions, safety statistics, company reputation, and safety record.

Seventy-four participants mentioned that they would investigate about/recommend their friends to investigate about non-safety related factors like price, location, training requirements, height, and technique. Ninety-three participants mentioned that they were interested in Bungee jumping. Fifty-four participants mentioned that they were not interested in Bungee

jumping. Eighty-four participants mentioned that they would investigate about/recommend their friends to investigate about safety related factors like safety instructions, safety statistics, company reputation, and safety record. Sixty-five participants mentioned that they would investigate about/recommend their friends to investigate about non-safety related factors like price, locations, health restrictions, and technique.

Discussion

A two-independent samples t-test showed that the SSBS scores of students in safety major was significantly higher than the SSBS scores of students in the non-safety majors. The SSBS was designed in a way that higher the score meant higher the safety behavior and vice versa. Hence it was determined that the students in safety major had higher safety behavior than students in non-safety major supporting the study's expectation that safety education influences safety behavior. A one-way between subjects ANOVA was run to identify whether SSBS scores of students in safety major was significantly higher than SSBS scores of students in every single non-safety major.

One-way between subjects ANOVA results showed that the SSBS scores of safety major students was significantly higher than UAS, ATM, and AMS majors but not significantly higher than AS and Aeronautics major. This could be because of the fact that the students in AS and Aeronautics major are enrolled in the flight school at ERAU Daytona Beach Campus which has a robust SMS program that has achieved IS-BAO stage II registration. This test showed a new perspective that students in AS and Aeronautics major who practice safety as part of their enrollment in the flight school scored high on SSBS similar to the safety major students. A two-tailed Pearson's correlation test was run to determine whether a correlation existed between number of safety classes taken and SSBS score. This test was run because The College of Aviation permits students in every major to take a wide range electives and minors.

Many students in non-safety major who participated in this study had taken safety classes as electives or minors. However, no significant correlation was observed between number of safety classes taken and SSBS scores. A Spearman-Rho correlation test was run to determine whether a correlation existed between SSBS score and RBS score; SSBS score and individual factor score in RBS. A significant negative correlation was observed between SSBS score and RBS score. This helped validate the SSBS scale because the higher score on the SSBS meant higher safety behavior and higher score on the RBS meant higher risk behavior.

Limitations

Sample size was a limitation of the study. The sample size was small because the study focused only on students in the College of Aviation at Embry-Riddle Aeronautical University. In addition to that, the study was conducted in a summer term, which does not see a large student enrollment and because of comparatively less students enrolling in safety majors than students enrolling

in Aeronautical Science and Aeronautics majors. Although there were only seven participants from safety majors, their mean score on SSBS was significantly higher than the mean score on SSBS of 142 participants from non-safety majors. This discovery was remarkable because significance was achieved with a small sample size i.e., low power.

Furthermore, the range of scores (63 to 81) for the safety majors was small, giving more confidence that this sample is representative of the population. This significant difference in scores between groups provides a foundation for future research attempting to determine safety behavior of students and provides confidence that a greater significance can be achieved between safety and non-safety students if a larger sample size is used. The results from SSBS also showed significant negative correlation with results from ethical, health, and gambling risk behaviors. This result implies that students exhibiting high safety behavior also exhibited aversion to taking ethical risks, health risks, and gambling risks. Thus, the SBSS shows convergent validity with the RBS.

Conclusion

First, the results indicated that students in a safety major reported significantly higher safety behavior compared to students in non-safety majors. However, it is unknown if the same results will be obtained when the survey is administered to students in safety majors willing to pursue a career in an industry other than aviation. There are multiple universities offering bachelor programs in Safety Engineering, Occupational Safety & Health, etc. If the SSBS administered to such students find similar results, it can substantially increase the reliability and validity of the survey.

Second, it is recommended that further research be conducted using the same study with students majoring in aviation from other institutions. One reason to conduct additional studies is to further corroborate the convergent validity between the SSBS and RBS. Another reason to conduct additional studies is to identify the factors that are increasing students' safety behavior. Additional studies may be able to identify specific coursework, which lead to safety behavior. Such further research could help universities offering safety coursework to promote those factors that impart the safety behavior in students. Such factors can then be embedded in the coursework of all students in a collegiate aviation program aspiring for a career in the aviation industry. With FAA mandating SMS for commercial airline operators by 2018 and recommending SMS for airports, flight schools, fixed base operators, repair stations, simulation facilities, ATC centers, and manufacturing organizations, the need for safety professionals in aviation industry and identifying courses that are associated with safety behavior are critical.

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