Student Flight Instructor Competencies

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ABSTRACT

The research literature addresses a variety of questions concerning flight instructor training, however, more research is needed to elucidate the instructional competencies associated with successful instruction in this critical field. This paper presents observational research to identify flight instructor competencies and patterns of instructional behavior. Flight instructor behaviors were defined in a computer-based observational tool that allows behaviors to be logged. Seventeen Certified Flight Instructor Instrument (CFII) students were videotaped as they were instructing Instrument flight students on a flight simulator. The researchers coded the student's behaviors using an observational data collection tool. Observed behavioral patterns are presented. The identification of critical instructional competencies during training and the use of the computer-based behavior logging tool in training flight instructors is discussed. Follow-on studies to further investigate methods of enhancing instructor performance are presented.

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INTRODUCTION

Pilot instructing was first done by the Wright Brothers as they taught themselves to fly, and then taught their early customers. From that time forward hundreds of thousands of aviators have served as flight instructors (civilian term) and instructor pilots (military term). Not surprisingly, after the early days of flight instruction the instructional role has always fallen to aviators who have a good bit of aviation experience. Instructors are usually chosen because they have shown their skill at aviation. However, as is the case with university teaching, skill at instructing is not necessarily a major criterion for being selected. It is not typically known who will be a good flight instructor until a candidate has tried to instruct. The literature review below will show that after all these years the aviation community has little in the way of analytical evidence that informs those responsible for instruction about how best to select or train flight instructors. It is fair to say that flight instruction is still far more art than it is science.

Our literature search has revealed few studies that examine analytically or empirically the question, "What makes a good flight instructor?" In addition, we have found few research based articles that ask, "How can flight instructors be better prepared?" While the military has a number of quality courses for preparing instructors, their curricula do not have a substantial theoretical or analytical base. Pedagogical skills are taught, but providing instructor candidates and their instructors with a well researched set of models for quality instruction is not possible because such research is not available.

We undertook this research with the goal of developing instructor guidelines based on sound instructional theory and analytical data. We desired to provide a set of valid guidelines that could be used by new instructors with behaviors that would result in better teaching. We desired that these modeled behaviors could be used in simulators and aircraft cockpits. Rather than base these instructional behavioral models only on subject matter expert opinion we felt it important to model excellent instructor behaviors so that new instructors could attempt to emulate the excellent instructors' approach to teaching.

LITERATURE REVIEW

Current Civilian Instructor Pilot Training

The Federal Aviation Regulations 14 CFR Part 61.181 outlines the eligibility, aeronautical knowledge, and flight proficiency requirements for flight instructor applicants (FAA, 2005). Prior to becoming a flight instructor, applicants must pass two multiple choice written exams: one on the fundamentals of instructing and another on general flight knowledge. Recent research suggests that most applicants memorize the correct answers (Casner, Jones, & Irani, 2004). Nevertheless, flight instructor applicants are verbally quizzed by a Designated Pilot Examiner during the oral exam which they must pass as well. According to the Practical Test Standards, the Designated Pilot Examiner has the responsibility for determining that the applicant meets acceptable standards of teaching ability, knowledge, and skill required in each of the tasks found in the Practical Test Standards (FAA, 2002). Most of the tasks in the Practical Test Standards require that the applicant demonstrate instructional knowledge by being capable of using the appropriate reference to provide the application or correlative level of knowledge of a subject, procedure, or maneuver. The applicant must also follow the recommended teaching procedures and techniques explained in the Aviation Instructors Handbook (FAA, 2002). This means that the instructor applicant comes prepared with a lesson plan outlining the objectives, elements, and completion standards for the lesson they are going to teach their Designated Pilot Examiner. Generally, a

flight instructor will help their instructor applicant or student develop a lesson plan, and practice giving the lesson to their instructor. Unfortunately, this may be the only instance in which the applicant may use a lesson plan, as many flight instructors do not create lesson plans prior to scheduled flights or ground training. Finally, the applicant must satisfactorily pass a practical test on the areas of operation listed in 61.187(b) and must once again demonstrate instructional knowledge in the elements and common errors of a maneuver or procedure (FAA, 2005). A typical flight training session for an instructor applicant in order to prepare for the above practical test requires that the student instructor practice instructing on their instructor, who will play the role of both mentor and student.

Shortfalls of the Current Flight Instructor Certification Process

The method described above for determining flight instructor competency is insufficient. As Machado (2005) described, "It is better to spend three years looking for a good instructor, than spend three minutes with a bad one". Although the FAA has a stringent certification process, ineffective instructors occasionally progress to student instruction (Wright, 2003). Further research will be necessary to mitigate this problem. Perhaps the reason is because flight instructor applicants can easily pass two written tests, teach a few lessons to their flight instructor, and show their teaching ability to a Designated Pilot Examiner who has a widely varying view of competency (Hunt, 2001). In this example, a flight instructor applicant has only been teaching to an audience that already knows the relevant information to a level higher than the applicant. Instructors know what examiners are looking for, and therefore, often teach their student to just pass the test, robbing them of the skills, knowledge, and attitudes necessary for daily flight (Hunt, 1997; Lintern, 1995; Moore, Lehrer, & Telfer 1997). The maneuvers required on the practical test do not have content or criterion validity (Blickensderfer, Schumacher, & Summers 2007). Role-playing as an instructor toward their designated examiner during the practical exam and to their instructor during training is confusing and unrealistic. This is evident in research done by Henley (1995) in Canada and Australia, and in the United States, it is understood by the FAA to be taking place (Wright, 2003).

Further research in the field of aviation instruction competencies would yield a better understanding of the requirements for training instructors. It may be valuable to consider the research of the Committee on techniques for the Enhancement of Human Performance which discovered that performance during training is an unreliable predictor of learning real world tasks (Druckman & Bjork 1994). Instructor applicants are sure to find that teaching their flight instructors and Designated Examiners is a simple task since they already understand the material. However, when given the task of training a new student, questions remain concerning actual instructional effectiveness.

Flight Instructor Training Research

Although the training of pilots has received a great deal of empirical research attention over the years, a review of the literature revealed little in terms of addressing the multiple factors associated with good flight instruction in military or civil aviation. A number of researchers, however, have addressed specific issues associated with flight instruction.

One line of investigation addresses pilot performance rating by instructors. In one study, Mulqueen, Baker, and Dismukes (2002) investigated the rating behaviors of commercial flight instructor's evaluations of pilots' technical and Crew Resource Management (CRM) skills in a flight simulator scenario. The goal of this effort was to assess the extent to which instructor ratings of pilot performance were accurate and reliable. Results indicated that participants had more difficulty assessing CRM skills than technical skills and that rating inconsistencies existed, suggesting the need for rater training programs to address these issues. In another study, Greenwood, Holt, and Boehm-Davis (2002) evaluated the efficacy of two training interventions to enhance inter-rater reliability among airline instructor pilots. One focused on conceptual knowledge while the other focused on procedural knowledge. The findings indicated that while participants in both training tracks experienced increased learning of concepts and procedures, participants in the procedural track reported higher levels of pre- and post-workshop knowledge. The authors conclude that the use of multiple index profile inter-rater reliability led to improved reliability of groups of raters and also that evaluators/instructors that lack a statistical background could indeed use a procedurally-based evaluation system.

In a study of the use of facilitation by instructors in debriefing following Line-oriented flight training simulator sessions, the techniques utilized by the flight instructor were investigated (Dismukes, Jobe, &

McDonnell, 1997). In this study, the ways in which commercial flight instructors facilitated crew self-reflection and self-assessment following a simulator flight were explored. While a focus on crew performance was evident, instructors were more likely to emphasize the positive events of the session rather than the aspects that needed improvement. Furthermore, the sessions were marked by frequent instructor questions to stimulate discussion. Included in the behaviors evident among the instructors who facilitated the debriefings effectively were: the use of questions that promoted self-analysis, appropriate silence, active listening, and follow-up questions. Interestingly, when effectiveness of facilitation skills was analyzed, a bi-modal distribution emerged, with a large group of instructors in the "good" to "very good" range and another large group in the "marginal" range. These results strongly suggested the need for facilitation training that includes hands-on practice and mentoring from instructors experienced in facilitation techniques. In another study, Beaubein and Baker (2003) found that there were no differences between team and instructor-led flight debriefings. Although the researchers reported that these debriefing methods were equally effective, further research was recommended to investigate ways to improve debriefing effectiveness.

A number of studies concerning flight instructor education were conducted by Irene Henley and her colleagues. In one study, a survey was conducted to elucidate the factors associated with the development and evaluation of flight instructors (Henley, 1991). Results of this survey showed that flight instructor training is highly influenced by traditional methods of flight instruction such as rote memorization and modeling other instructors. Deficiencies noted were a lack of identifiable instructor competencies and insufficient training in instructional methods. In another survey-based study, Henley (2001) discovered that the main hindrance to student learning in aviation education was their instructor, the very person who should be focused on promoting student learning. Specifically, flight instructors caused the most stress for flight students and were called, "the weakest link" in flight training (Henley, 2001).

These investigations provide valuable insight into some of the key factors associated with effective flight instruction. Gaining a greater understanding of the *behavior patterns* that are related to effective instruction during flight, however, is the goal of this research program.

Instructor Competencies

In an effort to ensure that personnel have the requisite skills to perform their jobs, employers are increasingly relying on the use of professional competencies in selection and hiring decisions, performance assessment, and training programs. The Department of Education for example, sponsored a program to develop an Instructor Competencies Assessment Instrument based on previously identified adult educator competencies (Sherman, Dobbins, Crocker, & Tibbett, 2002). This instrument is used in a variety of adult educational settings.

The International Board of Standards for Training, Performance and Instruction (IBSTPI), in cooperation with the Association for Educational Communications and Technology, conducted an empirical study to determine the competencies associated with effective instruction (Klein, Spector, Grabowski, & de la Teja, 2004). The use of the IBSTPI competencies for the current study will be discussed further in the methods section of this paper.

Observational Data Collection

Observing participants and collecting data in a natural setting often pose a number of challenges. It is widely accepted by research practitioners that the mere act of observing behavior may in fact change that behavior. While it is difficult to determine the extent to which this occurs in any setting, researchers try to minimize their impact on behavior in a number of ways. Using a recording device is one way to minimize the effects of the observer.

How to collect the data may pose additional challenges. It may be difficult to interpret, process, and record behavioral data during fast-paced human interactions. If the behaviors of interest are few, it may be possible to effectively collect the data in real time. The complexity of the environment, along with the number of observed participants, however, quickly exposes the limits of the researcher.

In an early attempt to automate observational data collection, a typewriter was modified to record the interactions of teachers and students in a classroom setting. (Young & Wadham, 1975). The Time Interval and Categorical Observation Recorder (TICOR) was designed to facilitate the coding of behavioral data and allowed the capture of the duration of the behavior. This system allowed researchers to ascertain patterns of behavior between the student and the instructor, leading to the ability to

conduct cause-and-effect analyses. The system was devised so that the recorder could enter a behavior, along with the quality of the behavior with as little as three keystrokes. For example, an incorrect learner response would require the researcher to enter R-. Because time and duration data were collected, researchers could then analyze patterns in the behaviors of the students and the teachers. Although this was a very innovative at the time, a number of more sophisticated computer systems have been developed to collect behavioral data. One such system was selected for this Instructor Pilot Training study and will be discussed in greater detail below.

METHODS

Development of Behavioral Assessment Tool

The research effort discussed in this paper is the most recent in a series of studies investigating instructor pilot behaviors, leading to the development of a tool to aid in training. Working with instructors at Arizona State University's aviation department, The Air Force Research Laboratory identified instructor pilot behaviors that facilitate student learning. Initial instructor behaviors were derived from the instructor competencies research conducted by IBSTPI (Klein, Spector, Grabowski, & de la Teja, 2004). A comprehensive set of behaviors was identified in this research effort, and from that set, a subset that was most relevant in the aviation setting was derived. The reason for limiting the number of behaviors for the current effort was twofold. First, not all of the behaviors identified by IBSTPI are used in one-on-one instruction. For example, improving professional knowledge and skills is undoubtedly imperative for instructors in any field; however, the behaviors associated with this competency would be difficult to quantify in the context of the present study. Secondly, the investigators felt that it was more important to focus on the most relevant behaviors for one-on-one instruction in typical aviation instructional experiences. Specifically, a great deal of instructor-student interaction takes place in a simulator, aircraft, or a briefing/debriefing setting. Focusing on the key behaviors in these settings would result in a more useful tool for instructors to use in simulator and cockpit training.

To further refine our list of behaviors, experts in the field then supplemented the initial behavior set to include several aviation-specific behaviors. For instance, if done appropriately, assisting a student when workload limits are exceeded facilitates learning. Depending on the student's level of proficiency, events for which a student does not have experience may interfere in the student's ability to absorb the objectives of the training session. Instructor intervention in events that are not relevant to the session allows the student to focus on flight objectives. Conversely, if an instructor intervenes too often, the student may become over-reliant on the instructor, and may not learn the important points of the lesson. Capturing such behaviors was imperative for accurate assessment of flight instructor teaching behavior.

The behavior set was then entered into a data collection software package. A behavioral analysis research tool, Noldus Observer XT facilitates coding of the behaviors of one or more participants in an observational research setting (The Observer XT, n.d.). Once the behaviors are entered into the system, the patterns of behavior may be represented on a chart (figure 1). These charts may be used by instructor pilot trainees to gain a better understanding of the behaviors they used in a training session. Furthermore, if learner behaviors are also coded, the ways in which students respond to instructor actions may also be assessed. Over the course of several semesters, data were collected during training sessions on a simulator. The researchers and flight instruction experts assessed and refined the behaviors under investigation. The results and findings of these previous efforts led to the development of the methods for the present study.

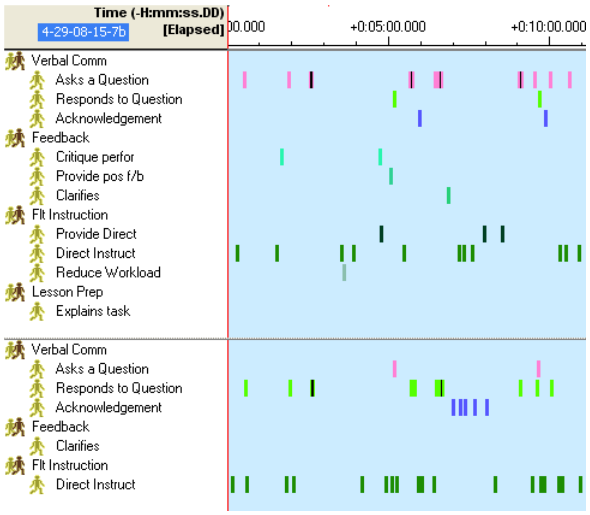

Figure 1. Noldus observed behavior chart.

The Present Study

During the spring 2008 semester at ASU, 17 flight instructor trainees were recorded while instructing

instrument flight students on a flight training device. These instructors-in-training hold a commercial certificate with an instrument rating and are working toward obtaining their Certified Flight Instructor (CFI) certificate. The instrument students are working on obtaining, or currently have, a private pilot certificate, and are beginning their ground training in instrument flight.

The equipment used for the training sessions consisted of an ELITE PI-126 Personal Computer Aviation Training Device (figure 2).

Figure 2. Personal Computer Aviation Training Device.

Using this device as a training platform, the student instructors taught instrument training skills such as holding, tracking a Non-Directional Beacon (NDB) or Very high frequency Omni-Directional Range radio (VOR), or a segment of an instrument approach. Scenarios were also flown in which the student instructor and instrument student had to fly an instrument approach with air traffic control. The researchers observed 19 sessions. The video recordings were then coded by the researchers using the observational software discussed above. For the current study, the 22 behaviors previously defined were used with each behavior given a keystroke assignment (see figure 3).

The behavior "Ask a Question" for example, was given the keystroke "aq," so that when watching the video recording, each behavior observed could be coded in real-time by a simple keystroke. After each observation, the observational tool provided the number of times each behavior was coded in the observation, as well as other descriptive information. Since each observation was 15-40 minutes in length, the researchers used rate per minute (RPM) data for each of the behaviors so that time was not a confounding factor in our analysis. Not every behavior was analyzed, as some did not occur, or occurred too rarely, to prove meaningful. Any behaviors that occurred fewer than 5 times were excluded from the analyses. Thus, 9 behaviors proved useful for the study. Behavioral data were then used to generate observed behavior charts, depictions of the occurrence of all behaviors over time.

Behavior Name	Description	
Non-Verbal Comm		Nn
Directional que	Get student attention (point...	dq
Verbal Comm		vc
Speech Inaudible	Can't hear what was said	si
Inapprop Comm	Inappropriate communication	ic
Asks a Question	Asks a question	aq
Responds to Question	Answers student question	rq
Acknowledgement	not in response to question	ac
ATC call	talks to ATC	at
Feedback		fb
Critique perfor	Provides constructive critici...	cp
Provide pos f/b	Provides positive feedback	pf
Clarifies	Explains to clarify misunder...	cl
Apologize	apologizes to student	ap
Flt Instruction		fi
Intervenes	Corrects student	in
Not aware - beh	Not aware of student beha...	na
Lost SA	Lost situational awareness	lsa
Lost control WL	Lost control of workload	lc
Provide Direct	Tells student how to fly	pd
Direct Instruct	Provides a truism	di
Reduce Workload	IP helps student - heavy w...	rw
Model	IP models behavior	mo
Teaches Incorrect	IP teaches incorrect inform...	ti
Lesson Prep		lp
Discuss Objectiv	Discuss lesson objectives	do
Explains task	Describe/explain maneuver...	et

Figure 3. Flight Instructor Behaviors.

RESULTS

The observed behavior charts displayed a great deal of variation among the student instructors. Refer to table 1 for a chart depicting the rate per minute (RPM) of each of the behaviors. Although conclusions may not be drawn because we do not have performance data, it is interesting to note the large differences in instructor behaviors across the different observations. Some instructors talk to their students nearly continuously while others seldom talk at all. In the sessions observed for this study, the more behaviors the student instructor exhibited, the more behaviors the student exhibited ($r = .685$, $p < .01$). The three most frequently occurring behaviors

were: direct instruct (e.g., providing a truism, such as "we are at 2000 feet"), provide direct (e.g., provide a command, such as "descend to 2000 feet"), and ask a question. The three least common of our selected behaviors were: clarifies, reduce workload, and explains task.

Table 1. Student Instructor Behavior Rates

	Rate Per Minute (RPM) Across All Student Instructor Observations				
	Average	Minimum	Maximum	Std. Dev.	Sum
Acknowledgment	0.33	0.00	0.62	0.16	3.28
Responds to Question	0.38	0.00	1.02	0.29	7.18
Asks a Question	0.53	0.00	1.38	0.44	10.14
Explains Task	0.20	0.00	0.57	0.18	3.74
Reduce Workload	0.16	0.00	0.42	0.13	2.98
Direct Instruct	1.08	0.34	2.37	0.52	20.47
Provide Direct	1.03	0.11	2.16	0.55	19.51
Clarifies	0.11	0.00	0.39	0.12	2.04
Provide Postive F/B	0.33	0.00	1.21	0.30	6.33

DISCUSSION

It is anticipated that the tool being developed for this research program will provide a valuable resource during the training of future flight instructors in civil and military aviation. Although video tapes for reviews of instructional behavior are seldom used during debriefings, one could argue that doing so could enhance self- and instructor-assessment. The inclusion of the tool being developed through this research program will provide valuable information on the frequency and distribution of instructional behavior. Furthermore, this tool will enable student instructors to evaluate the ways in which their students respond to instruction.

Figures 4 and 5 depict the behavior patterns of two of the instructors that participated in the study. Coded instructor behaviors appear above the line; student behaviors are represented below the line. The behavioral patterns depicted in figure 4 suggest that the instructor is proactive, periodically asking the student questions in order to determine their level of understanding. The student responds to questions and asks some of their own. The observed behavior chart also reveals that this instructor offers positive feedback to the student and clarifies information at various points in the simulator session. It is also useful to note the behaviors that did not appear in the observed behavior chart. For instance, critiques were not provided, and the instructor did not intervene or reduce workload during the simulator session. Depending on the circumstances of the flight, the presence or absence of these behaviors may be meaningful, potentially prompting discussions concerning instructional improvements.

In contrast, the instructor's behavior pattern depicted in figure 5 shows that this instructor exhibited much less activity. This instructor was passive, asking no questions and only responding to a few posed by the student. This is not to say that one of these instructors is better than the other; rather, these differences can be easily viewed by a student instructor who can make the determination based on the situation, depending on what was more appropriate for the session.

Future Research

The researchers have many suggestions for future research. During the next semester, research plans include obtaining model behavior patterns from expert flight instructors. These behavior patterns are expected to be useful guides for student instructors in developing their instructional techniques. These patterns are not intended to be a prescription for effective instruction; rather they offer alternatives for different approaches to instruction.

Since flight training is not one-size-fits-all, instructors must be able to tailor their instruction to meet the educational needs of the student. This research into instructional behavior patterns may shed light on the effectiveness of different techniques. Commonly, beginning student pilots need a great deal of interaction with their instructors, whereas checkride-ready students require significantly less. By assessing flight specific behavior patterns of both student and instructor, adjustments could then be made to achieve the optimal flight training environment.

Finally, recording student instructors on a simulator has been useful for developing our methods, but we intend to take this idea into the cockpit to observe certificated flight instructors teaching actual students to become flight instructors.

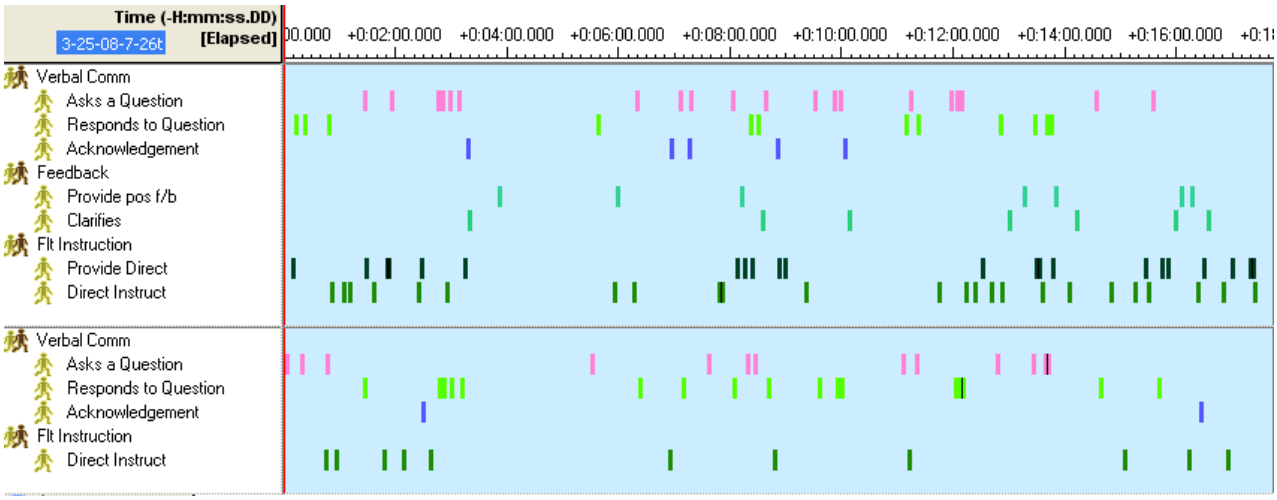

Figure 4. Instructor 1 behavioral pattern.

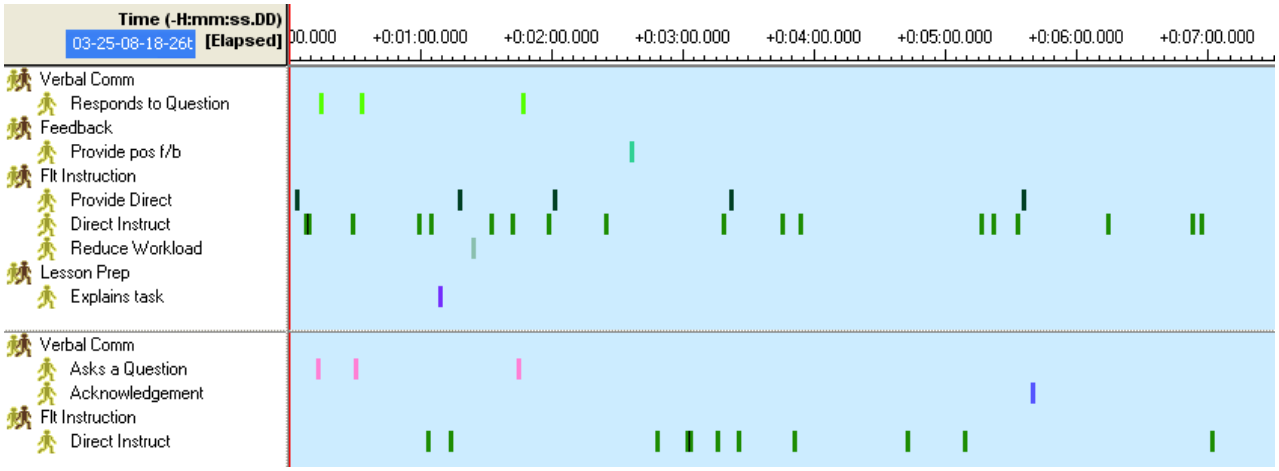

Figure 5. Instructor 2 behavioral pattern.

ACKNOWLEDGEMENTS

Thanks to Mr. Ron Diedrichs, and Dr. Richard Charles for their support in making this research possible and for their continued support of the AFRL/ASU research partnership. The authors would also like to thank Mr. Harry K. Pedersen for his assistance in preparing this manuscript.

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