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Article · November 2023

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Flight School, A Tiered Peer-Mentoring Program That Benefits Students And Faculty

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Abstract

While research on mentoring has been extensive, research on tiered peer mentoring is limited, particularly at regional comprehensive institutions like ours, where the majority of the students are from populations that are underrepresented in STEM fields. Here, we describe and report preliminary results from our NSF-funded conceptual model "*Flight School*," a model that utilizes a tiered peer-mentor structure, allowing students and mentors to engage directly with their learning experience, provide feedback, and make real-time adjustments to their learning process. The tiered structure includes a Pilot (faculty member), one Co-Pilot (peer-mentor), and three Navigators (peer-mentors) in a class. Peer mentors and faculty are trained in community building, communication, lesson planning, and concepts from educational and cognitive psychology. During the semester, faculty and peer-mentor feedback about students' learning is used to accomplish real-time adjustments in the classroom. We evaluate the effectiveness of Flight School using multiple measures, including curriculum inventories, questionnaires about mentoring, belonging, and motivation, as well as DFW rates. Results from the Flight School model in Anatomy and Physiology and Introductory Biology courses over two semesters showed an increase in learning gains, sense of belonging, engagement with faculty, gains in mentoring skills, and reductions in DFW rates. Anecdotal evidence indicates that peer mentors increased their content knowledge and leadership skills, and had a more enjoyable class. Faculty in Flight School also reported a more satisfying experience facilitating learning experiences. We think that Flight School can emerge as a mechanism to increase minority representation in STEM jobs and careers because it empowers students to advocate for their learning and provides equitable education in groups that have been historically oppressed.

Introduction & Literature Review

For centuries, Black Alabamians were denied, even killed, for attempting an education. When Black Alabamians were allowed to attend schools, they were forced into underfunded separate spaces that lacked basic resources. The decision of the Supreme Court in Brown vs. the Board of Education (1954) had the objective of ending segregation in schools, but instead, in 1963 Governor George Wallace was still able to claim that "there is not a single integrated school in Alabama yet." Integration finally started in 1964, when the Civil Rights Act gave the federal government the power of withholding funds to schools that were not integrated; as a result, white families sent their kids to 'segregation academies', private schools that were independently funded and were able to select their pupils (white pupils). As a consequence, the Montgomery Public School (MPS) population turned mostly African American, a ratio that has not changed much today (~8% of MPS students were white in 2022). Currently, many Alabama public schools are insufficiently funded by property taxes collected from homes whose values were depressed from historic redlining, a policy that restricted property values primarily in African-American neighborhoods (Hamill, 2008). A significant number of public schools in Montgomery lack basic resources and are housed in decrepit buildings that, in some cases, still have the names of Confederate leaders. Because of this deliberate lack of funding, it is not a surprise that the scores in mathematics, reading, science, and writing for Alabama students are among the worst in the country (www.nationsreportcard.gov).

Unfortunately, when new students enter many of our university STEM courses, they encounter an educational environment that does not address their academic or psychological needs. Classes are usually delivered unidirectionally, not addressing (nor gathering) student feedback in time for change, and require students to complete much of their learning with minimal prompting, feedback, or support. Usually, in these classes, there is a disconnect between faculty and students' expectations, resulting in high DFW rates. High DFW rates are problematic and discouraging not only for students but also for faculty. When a large number of learners consistently perform poorly in a faculty's course, the administration begins to question the effectiveness of the faculty. It uses these DFW rates to justify poor performance evaluations, withhold raises, and deny promotion. The mixture of systemic inequities in K-12 education and a lack of pedagogical training for college faculty, results in DFW rates in freshman STEM courses that are among the highest in the department (in some cases, more than 50%). Sadly, most students who fail their first Biology class never graduate.

Our 4-year university is a comprehensive institution in the Southeast, with ~5000 students and an acceptance rate of 97%. Roughly, 53% of our students are minorities, 25% are over the age of 25, 50% are Pell Grant eligible, 50% are first-generation college students, and most of our students have at least one job. The majority of our students attended Alabama public schools and are the product of its traditional systemic inequities, leading to a significant segment of students that enter our institution lacking some academic skills, content knowledge (incoming freshman ACT scores ~20), and agency. At our institution, we understand that our students are a product of an educational system that, by design, underprepared them to succeed in college.

"Access is nothing but a cruel joke if we simply define it as allowing students in the front door and then letting them drift through campus and curricula as they may" (Gannon, 2020, p. 74). At our institution, we want to do more than just grant access. We are implementing a vast body of strategies that have been scientifically proven to promote inclusivity and increase student learning, which are briefly described here. The design and implementation of an active learning framework that is inclusive and uses anti-racist pedagogies increases student learning and the representation of minorities in STEM education (Wilson et al., 2015; Dewsbury & Brame, 2019). Faculty need to develop a solid community as a foundational step to building knowledge and trust (McWilliams et al., 2008; Wilson et al., 2012). Additionally, faculty need to set and communicate attainable learning objectives that are aligned with activities and assessments, along with continuous formative assessments that move away from 'deficit thinking' (Smith, 2012) and will result in growth mindsets in students.

Growing evidence demonstrates the fundamental role that a peer mentor can play in students' success in college (Wilson et al. 2012). At our institution, peer mentors are students that have successfully completed a course and are hired to go back into those courses to provide guidance to learners and serve as models of successful student behavior. Mentors have the potential to open channels of communication with faculty and summarize learners' understanding, increasing the amount of formative assessment used, and allowing faculty to guide the class more effectively. Our model also has the potential to develop agency in students, because as learners' recommendations are implemented, students realize that their voices are being heard, their opinions are important, and that they have the power to improve their own educational experiences (Callender et al., 2016).

Here, we propose an integral change in the way we facilitate learning in gateway courses in Biology. In this approach, a tiered peer-mentoring structure, coupled with training, and regular support, is implemented in the college classroom. We call this model '*Flight School*'. Here, we describe our model and present some of our preliminary results supporting the pedagogical changes that can improve student academic outcomes and faculty enthusiasm (Dewsbury & Brame, 2019; Hebert, 2019).

Content

What is Flight School?

Flight School uses a tiered peer-mentoring structure (Figure 1). This structure includes three Navigators, one Co-Pilot, and one Pilot in a course capped at 24 learners (from here on, we use the term 'learners' to identify the students that are enrolled in the course and not the peer-mentors, who are also students). Learners work in Squadrons facilitated by a Navigator.

The Navigators (represented by red triangles in Figure 1) build community, model successful student behavior, and facilitate student participation within the Squadrons. 'Navigators formulate questions and celebrate accomplishments, helping learners identify gaps in their understanding and increasing student agency.. Navigators can also provide advice on learning skills and help learners traverse the in-class experience. Navigators collect feedback from their Squadron, observe whether teaching and assessment strategies are effective, and report this information to the Co-Pilot and faculty

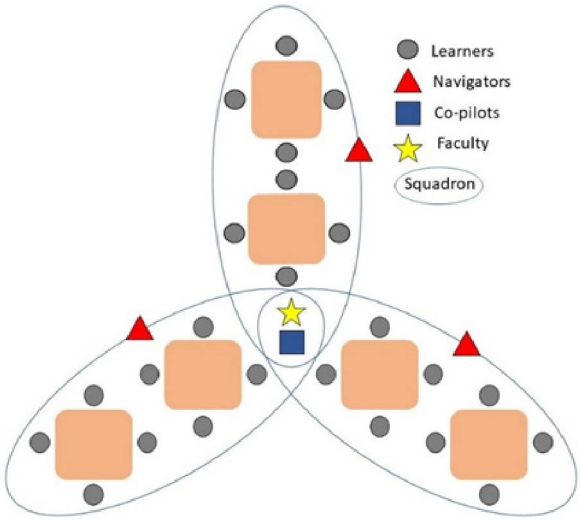
The Co-Pilot (represented by a blue square in Figure 1) is a peer-mentor that is a content expert (needs to have earned an A or a B in the course); the main responsibility of the Co-Pilot is to oversee the work of the Squadrons and provide faculty with feedback. Co-Pilots possess content knowledge, hold office hours, and are peer models of how to be successful in college and STEM specific courses. Co-Pilots are the main point of contact for Navigators and loop feedback to the faculty member.

The Pilot (represented by a yellow star in Figure 1) is the faculty instructor. The instructor facilitates learning, taking into consideration the peer-mentor feedback, that they receive. Co-Pilots, Navigators and Pilots meet regularly to discuss observations made in class, collate suggestions, problem solve, and prepare changes for

future class periods.

Figure 1:

Diagram of the structure of Flight School.



Learners (gray circles) are grouped into 8-person Squadrons, each with a Navigator (peer-mentor represented by red triangle). All Squadrons work with a Co-Pilot (peer-mentor represented with a blue square) and Faculty (Represented with a yellow star).

What support is provided in Flight School?

Three to six months before fall or spring semester begins, enrolled faculty are provided with information describing the program and are coached in recruiting peer-mentors. We have found that the highest recruitment of peer-mentors occurs when faculty directly approach their students and ask for them to participate in Flight School, explaining the needs and benefits of the tiered mentoring model, and what their own qualities are that made the faculty choose them to be peer-mentors. Remaining peer-mentor positions are filled by the department mentor coordinator (always verifying that the instructor and peer-mentors are agreeable). Faculty are trained and paid a stipend to implement the model. Navigators receive a scholarship each semester that they serve in Flight School; and Co-Pilots are hired as employees that are paid by the hour. Before class begins, all participants get ~20 hours of training spread over several sessions (workshops) over the course of 3-5 days. The main objectives of the workshops are to: (1) make and demonstrate the importance of building a classroom community; (2) learn and implement concepts from educational and cognitive psychology; (3) understand the need to develop lesson plans that utilize active learning aligned with formative assessments; and (4) understand the roles, limitations, and responsibilities of all Flight School members (training materials are available upon request from Dr. Ward at cward3@aum.edu.) During the semester, we carry out bi-weekly meetings with peer-mentors. These meetings serve many purposes: including (1) continue working with peer-mentors to improve group dynamics; (2) reinforce understanding of the concepts from educational and cognitive psychology; (3) discuss and practice facilitation; (4) discuss and assess implicit bias; and (5) gather feedback that is looped back to the faculty. In addition, we conduct monthly meetings with faculty to provide supportive guidance, collect faculty feedback, and encourage the continued implementation of the Flight School model in the classroom.

What are the expectations of Flight School participants?

Navigators and Co-pilots are expected to attend training and class meetings. In addition, Co-Pilots are expected to hold office hours and review sessions for learners throughout the semester. Pilots are required to attend training, plan with their peer-mentoring team, and implement science-based pedagogies that maximize student learning. It is also important for faculty and peer-mentors to meet regularly during the semester to design lesson plans for upcoming classes. We have found that these lesson plans lead to modifications of learning facilitation that include changes to class materials, and incorporation of small group learning. For example, during one of these meetings, a Co-Pilot mentioned that learners shared information between Squadrons and it was really beneficial to their learning. Sharing allowed learners to see multiple examples of concept maps and drawings that were different from their own, promoting learning and increasing understanding. As a result, the lesson plan was modified and class time was set aside to share Squadron

information. These team meetings increase the self-confidence of peer-mentors and allow Pilots to hear the feedback that peer-mentors have gathered. All members of Flight School (Pilot, Co-Pilot, Navigators, and learners) are required to participate in assessments of the effectiveness of the program. Flight School organizers (all four authors of this article) are expected to be knowledgeable, provide training and support, assess the effectiveness of the program, and disseminate the results.

Initial Results

To evaluate the impact of the Flight School pre-semester workshop for peer-mentors, we used the Undergraduate Research Student Self-Assessment (URSSA) (Hunter et. al., 2009; Weston & Laursen, 2015) and Institutional Integration Scale (IIS) (Pascarella and Terenzini, 1980; French and Oakes 2004) questionnaires. During fall semester 2022, we hosted our pre-semester workshop in three training sessions; after the workshop, the URSSA and IIS surveys were given to participants. A total of 22 mentors completed the survey and results indicated that the majority of mentors were very satisfied with various aspects of the training including: the application process (91%), support and guidance from the program staff (86.3%), support and guidance from other group members (86.4%), and group social activities (86.4%). Every mentor who participated was satisfied with the support and guidance from their faculty mentor. Almost 40% of the mentors were not satisfied with the financial support. We followed up with the mentors and found that their dissatisfaction was primarily with the time that it took to get paid. We have remedied this issue.

The mentors were also asked to reflect on their personal gains associated with attending the Flight School workshop. Nearly 90% of the mentors noted that they gained confidence in their ability to do well in future science courses and to work independently. About 80% reported gains in their comfort with discussing scientific concepts and working collaboratively. One area that seemed to lag in gains was in their ability to contribute to science (<70%); however, this may change as they participate in Flight School and work with the faculty and other mentors now and into the future.

Table 1 shows the descriptive statistics for the Institutional Integration Scale (IIS) that was used to measure the mentors' sense of belonging on campus after the initial Flight School workshop. The results indicated that our mentors prioritized institutional goals and commitments including getting good grades but also that they were satisfied with their college selection. They also felt comfortable interacting with the faculty and felt they gained from these experiences. Specifically, mentors noted that their non-classroom interactions with faculty have had positive influences on their "intellectual growth and interest in ideas" (*M*=4.67, *SD*=.617) and "personal growth, values and attitudes" (*M*=4.67, *SD*=.488)

Table 1:
Descriptive Statistics for Institutional Integration Scale (IIS)

	M (N=15)	SD
Academic and intellectual development	4.06	0.776
Faculty concern for student development and teaching	4.40	0.849
Institutional goals and commitments	4.51	0.516
Interactions with faculty	4.51	0.606
Peer-group interactions*	4.03	0.699

*N = 14

We evaluated the effectiveness of Flight School implementation in courses by using multiple metrics on learners, peer-mentors, and faculty. During the first year of Flight School, four faculty implemented the model in three lectures (Introductory Biology I and II, and Anatomy and Physiology I) and one lab (Introductory Biology I lab); on average classes had 0.9 Co-pilots and 2.36 Navigators. At this time, results regarding faculty are limited to anecdotal experience due to our small sample size.

To assess learning gains in learners, we built questionnaires using content inventories for our courses. Specifically, for Anatomy and Physiology we built an inventory using the Human Anatomy and Physiology Society (HAPS) test and Openstax Anatomy and Physiology test bank questions (available upon request to mgrillio@aum.edu). Content inventories were given at the beginning and end of the semester and compared using a paired samples *t*-test. We found a significant difference in A&P content knowledge from the beginning of the course (*M*=18.04; *SD*=3.61) to the end of the course (*M*= 21.04; *SD*=5.21); [$t(24) = -3.731$, $p < .001$). A medium to large effect was found (*d*=-.746 95% CI [-1.185; -291]), indicating that students' scores increased

substantially.

We also compared DFW rates for all sections of target courses. The DFW rates of all courses implementing Flight School decreased. In the academic year prior to implementing this model, DFW rates in our Introductory Biology courses were close to 60%. In the first semester of implementing Flight School, the DFW rate dropped to 33%, and in the second semester of Flight School implementation the DFW rate dropped even lower, to 19%. It is worth noting that, for two of our Flight School instructors, the DFW rate for their second semester implementing Flight School was close to 4%.

Anecdotal Evidence

At the end of each semester, peer-mentors were surveyed about their experience in Flight School. Peer-mentors reported that the support provided in the program was useful to them and gave them tools and insights about how to help students learn. They also reported that peer-mentor meetings helped increase their connectivity with other peer-mentors, a key factor for a sense of belonging on a college campus. In some of the written feedback a peer-mentor wrote: "*The bi-weekly peer mentor meetings really help me see the best way to approach students within the classroom I was helping [mentoring]. It also helped me navigate how to help students to the best of my ability. I didn't really find anything about the bi-weekly meetings that wasn't helpful, it helped me contact other peer mentors and share experiences and learn new tools to use with students we are helping."* Another peer-mentor reported, "*What's useful for the bi-weekly meetings is to hear other peer mentors' suggestions and ideas to better help the students".* In the classroom, learners would often call the Co-Pilot 'Doctor' and keep a messenger chat with communication throughout the semester. It is worth noting that on the last day of the semester one learner brought a card to the Co-Pilot thanking them for all the help and guidance and saying *"I could not have done this without your help and support".*

For learners, it can be challenging to enter and engage with Flight School, because our students have mainly been conditioned in their previous courses with the traditional style of unidirectional lecturing. Often, students have met our model with confusion and resistance. In the first semester that Flight School was implemented, we found that in some cases it took several weeks for students to 'buy into' the model. However, as we have continued to build community, incorporate and modify lesson plans, and work with learners to actively engage in assignments, we have begun to see the positive effects. Students have engaged and worked together in groups, asking questions, helping other learners, interacting with peer-mentors, building STEM confidence, etc. For example, at the end of the semester one student said "*She [the instructor] has an active learning style, and while that was kind of hard to adjust at first it is very effective*." Another student, when asked what was best about the course, reported that "*...activities and group work is always a plus for students. But I wanted to also mention the peer mentors we had in our class. There were at least four in our classroom to help students while the teacher was helping other students. They also were able to break down material if we didn't understand it."* Towards the end of the semester, students really understand the model and see the positive effects that it has on their learning, and it is very common for students to ask Flight School faculty "*What other classes are you teaching?"* (or similar).

As faculty, it is challenging to stop traditional, unidirectional lecturing and get to know our students' stories and their lives. Yet, we need to connect with students in order to really *see where they are* if we truly want to *meet them where they are*. It hurts sometimes to know what experiences students have been through and/or are experiencing, but we need to do this in order to really 'see them'. Once our students perceive that we genuinely care about them, then they will put forth more effort; once they trust us, students will listen to our advice and will continue to develop effective strategies to study. The classes that we teach using the Flight School model are considered 'hard', as indicated by DFW rates before Flight School (almost 60%). However, once learners started to identify their own gaps in knowledge, they experienced a paradigm shift towards self-sufficiency. Additionally, learners in Flight School classes have very high attendance rates (at least 85% of the students attend consistently) and often gather at the door well before class starts, ready to participate. Our Flight School students interact with each other, talk, laugh, draw, create, build knowledge, and generally seem happy. As Flight School faculty, we are looking forward to meeting these people, interacting with them, and helping them develop the tools they need to find and fill their gaps in knowledge, leading to the development of skills that will carry them through college. Moreover, Flight School is contagious; regularly, other non Flight School faculty see our classes, products, and community and wonder how we do it and, even better, they ask if they can join us.

Conclusion

Our NSF-funded conceptual model, 'Flight School', utilizes a tiered peer-mentor structure allowing learn-

ers and mentors to engage directly with their learning experience, provide feedback, and make real-time adjustments to the learning process. Initial results indicate that training undergraduate students and faculty in community building, communication, lesson planning, and concepts from educational and cognitive psychology positively impact the learners, mentors, and faculty. Specifically, learners in Anatomy and Physiology I and Introductory Biology II showed significant learning gains, along with a reduction in their DFW rates. Additionally, mentors showed a greater sense of belonging in science and were more likely to engage with faculty outside of their regular classroom experiences. Anecdotal evidence indicates that peer-mentors increased their content knowledge and leadership skills, while the course appeared to be more enjoyable for the learners and faculty under our model. We think that Flight School can emerge as a mechanism to increase representation in STEM jobs and careers because it empowers students to advocate for their learning, and provides equitable education in groups that have been historically oppressed.

Acknowledgments

The authors would like to thank the students at Auburn University at Montgomery (AUM) that have served as peer-mentors (i.e. co-pilots and navigators) and students (i.e. learners) in our Flight School classes. Additionally, the authors thank AUM faculty and staff that have helped implement and run the model. Thank you to Justin C. Bagley for useful comments to this manuscript. Funds for this project were provided by IUSE-NSF 2216351 and US Department of Education P031A190185.

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