ASU EdPlus
Arizona State University

Dreamscape Learn

Research Report
Fall 2022–Spring 2024
Campus Immersion Retrospective

ASU EdPlus

The EdPlus Action Lab team at Arizona State University (ASU) is dedicated to transforming learning through rigorous data collection and scholarly research. Guided by our learning laboratory philosophy, we prioritize sharing research findings to encourage open dialogue about teaching and learning practices that drive meaningful educational impact. As an independent and objective evaluator, Action Lab assesses innovative interventions—such as Dreamscape Learn (DSL)—to expand educational reach and improve the quality and effectiveness of learning experiences.

This document presents a two-year retrospective study offering detailed insights into the performance of thousands of students enrolled in introductory biology courses. By analyzing course outcomes from Fall 2022 through Spring 2024, the study provides a historical overview of key trends and outcomes. EdPlus Action Lab hopes readers reflect on the findings herein with a focus on higher education futures that benefit all learners.

Warmly,

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Executive Summary

Dreamscape Learn's (DSL) Introductory Biology 181 and 182 labs at ASU deliver an innovative, student-centered curriculum combining advanced pedagogy, narrative storytelling, and immersive virtual reality (VR) experiences. Students engage with the Intergalactic Wildlife Sanctuary in VR, where they solve realistic problems, followed by lab sessions to analyze data and form hypotheses for testing in subsequent VR experiences. Each course in this two-term sequence provides 4-credit hours, including one credit dedicated to DSL-focused labs. This retrospective analysis examines data from 6,230 student experiences across both courses over four terms (Fall 2022-Spring 2024) to evaluate the impact of DSL. Of the 6,230 student experiences, 4,002 unique non-duplicative students met the research sample inclusion criteria and are put forth in this study as the population for our research. Key findings highlight high student satisfaction (median VR rating: 5/5) and immersive engagement (79 of 91 interviewed students felt immersed during their VR experiences). Importantly, DSL implementation has positively influenced academic outcomes, with students achieving improved grades in subsequent courses and better retention in STEM majors.

Additionally, consistently strong performance across all student groups highlights DSL's broad-based effectiveness. VR attendance correlates with increased engagement and higher lab assignment grades. Moving forward, actionable steps include enhancing visual character representations to reflect the ASU student population, deepening narrative elements to strengthen student connection, and developing more emotionally engaging storylines for future DSL products across additional content areas.

The Weekly Student Journey

DSL's Biology 181 & 182 offering is a complete curricular package inclusive of (1) advanced pedagogy expressed through student-centered design, (2) narrative storytelling that extends beyond the virtual reality (VR) experiences, and (3) two hours of total VR time experienced during each 15-week term. During each ~15-minute VR experience, students entered the Intergalactic Wildlife Sanctuary, where they discovered, investigated, and solved realistic problems grounded in the virtual world. Students then attended a three-hour lab session in which they discussed observations, analyzed data, formed hypotheses, and discovered patterns connected to the VR storylines. BIO 181 & 182 are an integrated two-term course sequence worth 4 credits per course, one credit of which covers the DSL labs designed for STEM majors.

Retrospective Context

This DSL biology retrospective relies on iteratively refined research protocols first developed for [DSL's pilot implementation in introductory biology courses at ASU in Spring 2022.](#) After Action Lab's Spring 2022 research, DSL scaled into all of ASU's School of Life Sciences (SOLS) campus immersion BIO 181 sections for the Fall 2022 term. In the following Spring 2023 term, all of ASU's School of Life Sciences (SOLS) campus immersion BIO 182 sections also received DSL. Action Lab collected data throughout DSL's implementation in BIO 181 (four terms from Fall 2022 through Spring 2024 covered by this retrospective) and BIO 182 (three terms from Spring 2023 through Spring 2024 covered by this retrospective). References in this report to "the study period" mean the four terms in which BIO 181 has had DSL, and the three terms in which BIO 182 has had DSL.

Key Takeaways

To create this retrospective, Action Lab looked at 6,230 student experiences across both courses over four terms (Fall 2022-Spring 2024). Of the 6,230 student experiences, 4,002 unique non-duplicative students met the research sample inclusion criteria and are put forth in this study as the population for our research. Research inclusion criteria necessary for our quantitative analyses described in this report include undergraduate students who did not receive W, X, or I final course grades and did not earn 0% on all DSL assignments. Action Lab drew insights from 4,648 paired pre-/post-course surveys from these students. In addition, these students were asked to complete 40,140 act-specific responses to post-VR surveys 9 times per term, and 14,551 engagement surveys completed 3 times per term, as well as 91 one-hour post-course student interviews, and 87 hours of classroom observations for this report. Key takeaways include:

1. Overall VR experience:
    a. The median BIO 181 & 182 student rating of their overall VR experience has been 5 out of 5 throughout the study period.
    b. 79 of 91 interviewed students felt immersed during their VR experiences.
    c. Previous VR experience and frequency of video game play, as understood from BIO 181 and BIO 182 student survey responses (n = 4,002 unique students), does not meaningfully impact students' feelings of immersion or ratings of overall satisfaction with their VR experiences.
2. SOLS students taking BIO 181 after the introduction of DSL labs have been more likely to remain in a SOLS major (for at least a year after taking the course) than students taking BIO 181/281 previously from academic years 2018–2022.
3. Students who took BIO 181 after the implementation of DSL had a 1/4 letter grade improvement in their final course grade in BIO 182 relative to their final course grade in BIO 181.
4. Tracking longitudinally, relative to their grade in BIO 181, students taking BIO 181 after the introduction of DSL labs also score ~¼ of a letter grade better in BIO 340: General Genetics or MBB 347: Molecular Genetics than students taking BIO 181/281 from academic years 2018–2022.
5. DSL assignment grade differences among student groups have remained stable since the rollout of the full DSL package in Fall 2022. Average DSL assignment grades ranged from 90.8% to 94.1% across all groups[1]. Action Lab analysis shows that, regardless of background, students consistently performed well on all lab assignments.
6. Path analysis shows that VR attendance is associated with flow state, which predicts students being more present and engaged during course activities, and with higher DSL assignment grades.

Actionable Next Steps

As DSL finds applications in new fields, Action Lab proposes the following actionable next steps for campus immersion with VR implementation:

1. Enhance visual character representations to align with the ASU student population, and deepen narrative elements to strengthen student connection. Additionally, incorporate more opportunities for student interaction within the VR environment.
2. Design future DSL products with emotionally engaging storylines that enhance student engagement and tie seamlessly to course content and assignments. Based on qualitative research, incorporate features that evoke emotions conducive to learning, and expand DSL integration into other course components, such as course lectures.
3. Continue long-term data collection to evaluate the impact of one year of introductory biology courses (BIO 181/182) with DSL on students' academic and career trajectories, particularly in STEM persistence and success. Strengthen causal inferences about its effectiveness with other new co-informing studies.

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[1] Averages represent estimated marginal means, which are the predicted average values of a variable, adjusted for other factors in the analysis to show their true effect.

BIO 181/182 Campus Immersion Summary Tables

	BIO 181 Campus Immersion	BIO 182 Campus Immersion
Class Length	15 weeks	15 weeks
Course Delivery	In-person lectures and lab sessions	In-person lectures and lab sessions
DSL Experiences	VR on campus and 3-hour in-person lab sessions	VR on campus and 3-hour in-person lab sessions
DSL Assignments	10	9

Research Sample

	BIO 181 Campus Immersion	BIO 182 Campus Immersion
Students	n = 4,064	n = 2,166[2]
Paired pre-/post-course surveys	2,867	1,781
Post-VR surveys (offered 9 times over 15 weeks)	25,589	14,551
Engagement Surveys (offered 3 times over 15 weeks)	9,069	5,482
Interviews	41	50
Observation Hours	54	33
Median Final Course Grade[3]	81%	88%
Median DSL Assignment Grade[3]	92%	91%

Endnotes

[2] DSL was not offered in the Fall 2022 term for BIO 182. DSL began in BIO 182 in Spring 2023.

[3] Median final course grade was calculated by examining final course percentages from all undergraduate students who participated in DSL courses from Fall 2022 to Spring 2024, and median DSL assignment grade was calculated by examining average DSL assignment grade from all undergraduate students who participated in DSL courses from Fall 2022 to Spring 2024. Students who received final course grades of W, X, or I were excluded, in addition to students who earned a score of 0 on all DSL assignments. In total, after exclusions, there were 5,750 student experiences from 4,002 unique students (BIO 181 = 3,677 experiences; BIO 182 = 2,073 experiences).

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1. Course Context

BIO 181 & 182 Two-Term Sequence

BIO 181 (General Biology I) and BIO 182 (General Biology II) are designed for STEM majors, covering key biological concepts and skills. BIO 181 focuses on molecular biology, cell biology, and physiology, using quantitative reasoning to explore cellular and organismal functions. BIO 182 emphasizes genetics, evolution, and ecology, applying similar reasoning to populations and ecosystems.

Each course includes a lecture (three credits) and a DSL lab (one credit). Students participate in VR experiences at the ASU Tempe campus, exploring the Intergalactic Wildlife Sanctuary. Following the VR sessions, students attend a three-hour in-person lab, where they analyze data, test hypotheses, and discuss their observations, guided by Teaching Assistants. See the supplemental information to read background details.

2. Progression Through The Introductory Biology Sequence

The full implementation of DSL labs in campus immersion sections of BIO 181 coincides with fewer students changing majors outside the School of Life Sciences (SOLS) after taking the course. From academic years 2018–2022 (before the implementation of DSL), 29% of BIO 181/281 campus immersion SOLS students switched majors outside SOLS within the year. In contrast, this number is only 24% among SOLS students taking BIO 181 since Fall 2022.

For students who remain biology majors, the next biology course in the major map is BIO 340 (General Genetics) or MBB 347 (Molecular Genetics). Students who pass BIO 181 and BIO 182 tend to receive relatively lower grades in BIO 340/MBB 347. From 2018–2022 (before DSL), campus immersion students completing BIO 181, 182, and 340 sequentially (Fall, Spring, Fall) performed more than a half-letter-grade worse in BIO 340/MBB 347 than they had in BIO 181. However, after the Fall 2022 introduction of DSL labs, this grade decline has shrunk by half to roughly a quarter-letter-

grade. Please see the supplement to this section for additional information.

In a previous study, Action Lab found that campus immersion students who took SOLS sections of BIO 181 in Fall 2022 and SOLS sections of BIO 182 in Spring 2023 showed markedly higher levels of achievement, as defined by their final course grade in BIO 182 relative to their BIO 181 grade, than students taking the same introductory biology sequence in prior years dating back to 2018. In Academic Year (AY) 2023, students had, on average, a nearly one-quarter letter grade improvement from BIO 181 to BIO 182. Conversely, before AY 2023, the transition from BIO 181 to BIO 182 (or their 281/282 equivalents) had entailed an approximately one-quarter letter grade decline in final course grade.

3. VR Experience Ratings

During the study period, Action Lab asked students to complete brief post-VR surveys to capture their reactions to the VR experiences. Students have consistently rated their overall experiences highly. Out of 39,815 valid responses from students who did not receive a final course grade of W, X, or I, the median rating is 5 out of 5. Please see the supplement to this section for term-by-term ratings.

4. Association Between Student Characteristics and DSL Assignment Grade

In previous DSL research compendia, Action Lab examined how various student characteristics were associated with average DSL lab assignment grades. Since the implementation of the DSL curriculum in Fall 2022, grade differences among students analyzed have been small and remained stable over time. Average grades across all groups ranged from 90.8% to 94.1%[4], indicating consistently high performance within the A grade range for DSL lab assignments.

Please see the supplemental file for a detailed breakdown of all characteristic factors and their impacts on the average DSL assignment grade over the two years.

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5. Prior VR Experience and Video Game Play

During the study period, 57% of BIO 181 & 182 students reported having prior experience with virtual reality, and 89% reported having previous experience playing video games. When reporting their current frequency of video game play, 5% of students reported never playing video games, 14% reported playing once a year, 14% once a term, 23% once a month, 27% once a week, and 15% daily.

After accounting for relevant covariates, neither prior experience with virtual reality nor current frequency of video game play were associated with overall VR experience ratings or VR immersion. See supplement for more information.

Lastly, we examined how prior VR experience and video game play frequency were associated with the average DSL assignment grade. Prior VR experience emerged as having a significant, but negligible, association with average DSL assignment grade, as this variable explained less than 1% of the variance in assignment grade when looking across all students. See supplement for more information.

6. Flow+ Factors and Performance on DSL Assignments

After each DSL module, Action Lab surveyed students to assess their experience of flow state, how present they felt, and how engaged they were in course activities. Full methodological information is available in the supplement to this section. Overall, across all modules, students reported high levels of flow state, moderately high levels of presence, and moderately high levels of engagement. We excluded students with W, X, or I grades from this aggregate path model, as well as those who received a score of 0% on their DSL assignments[5].

Participation in the VR experiences, which were required and each worth a small amount of points, was directly related to student performance on graded DSL assignments. The path analysis revealed that students who attended more VR experiences reported significantly higher feelings of a flow state. Higher feelings of a flow state led to feeling significantly more present during course activities, leading to feeling significantly more engaged with course activities. In turn, more engaged

students performed significantly better on their DSL assignments (Figure 1).

Figure 1. Depiction of the Direct and Indirect Relationships Among Measures of VR Attendance, Flow, Presence, Engagement, and DSL Lab Assignment Performance
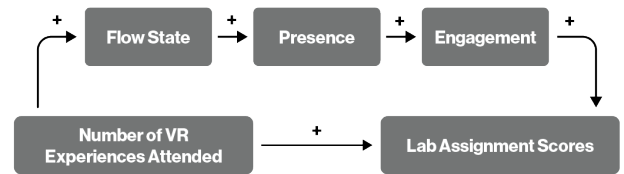
7. Cognitive, Emotional, and Social Engagement

During the study period, Action Lab asked students about course engagement at the end of each VR module. These surveys measured students' cognitive, emotional, and social engagement in the course as a whole. Median ratings for all engagement constructs were 5 out of 7 during the study period, indicating that students felt highly engaged cognitively, emotionally, and socially in their BIO 181 and 182 courses. One survey item in particular, "I worked with other students on course areas I had problems [with]," had a median rating of 6 out of 7 nearly every term since Fall 2022. See the supplement for more information.

8. Qualitative Research

The qualitative interviewees' top-line demographic factors – gender, Pell eligibility, and student group characteristics – significantly and directly represent the broader population of students who participated in BIO 181 and 182 during the study period. In short, Action Lab interviews represent the students who enrolled in this course over a two-year period.

Avatar Customization

Many interviewed students expressed a desire for greater variety in avatar options throughout the study period. Suggestions included offering more customization features and a broader selection of characters to support stronger personal connection with avatars. Students also recommended providing a list of avatar features to choose from during setup.

For more detailed feedback from student interviews, see the [supplemental document](#).

Connection Between VR Experiences and Students' Lab Activities

During the study period, Action Lab conducted both observations (totaling 69 hours of direct observation) of DSL labs and interviews with students in those labs throughout the study period (n = 91) for both BIO 181 and 182. In Spring 2022, 12 three-hour lab observations and (n = 39) hour-long interviews were conducted.

In both BIO 181 and 182, students drew on their immersive VR experiences to enhance their understanding and application of biological concepts in their labs. The storylines presented in the DSL experiences exemplify emotional design, using design features to induce emotions conducive to learning. In addition, we found that the majority of interviewed students felt immersed in the VR experiences (n = 79/91) and that what they saw in the VR experiences was directly related to their lab activities (n = 50/65) or helped them feel like real scientists in a lab setting (n = 20/26).

In Fall 2022, during a BIO 181 lab session, the impact of the DSL scenarios on students' understanding was clearly visible. While discussing a lab question about blood flow, a student asked, *"So she's not getting enough blood to her head?"* This question directly referenced the physiological challenges faced by the "megaraffe Xor," a character in the VR scenario they had experienced. Another student immediately reinforced this understanding by saying, *"That's why Xor passed out! It makes sense."* These micro-interactions demonstrate how the DSL VR experience provided a contextual framework that students could leverage when interpreting data and solving problems in their lab work.

By Spring 2023, DSL was fully implemented in BIO 182 with new storylines. Almost all students (n = 34/37) reported feeling deeply immersed in the VR environment, with one student recalling, *"I just got jump-scared by my bio lab,"* During one lab session, a teaching assistant humorously remarked, *"Xor was 181; I know nothing about Xor!"* sparking laughter and a discussion among students, who referred to Xor as "the head of the herd."

One student even commented on the character's supposed death and return, saying, *"I was sad about Xor dying."* This exchange shows how deeply the DSL characters and scenarios had become embedded in the students' shared learning experience, influencing their interactions and discussions in the lab.

In Spring 2024, all interviewed BIO 182 students (n = 13/13) felt easy and confident using the VR technology. One student shared, *"I think it was the baby eggs on the beach, and they were hatching, and they had to get to the ocean before the plants fell on them. I remember after we all took off our headsets, our table was talking. We were talking about how distressed we were when one of the babies died. We wanted to shout,"* when discussing the emotional impact of the storyline. For more information on qualitative findings regarding the connection between VR experiences and students' lab activities, please see the [supplement to this section.](#)

Endnotes

[4] Note that these averages represent estimated marginal means, which are the predicted average values of a variable, adjusted for other factors in the analysis to show their true effect.

[5] We excluded students who received a "W", an "I", or an "X" as a final course grade because they did not have an opportunity to complete all lab assignments. We excluded students who received an average DSL assignment grade of 0% as they did not participate in any DSL aspects of the course.

Please see the [full list of contributors](#) who graciously supported this study.

Questions?

Contact Action Lab, Arizona State University

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This research is approved by Arizona State University's Institutional Review Board for human subjects research: STUDY00013163, STUDY00015266, STUDY00015062

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