NORTH TO THE FUTURE: A NEW ASYNCHRONOUS DELIVERY OF THE CLASSIC "FLORA CLASS" AT THE UNIVERSITY OF ALASKA FAIRBANKS

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ABSTRACT

Alaska is relatively isolated from the rest of the United States, due to its distance, size and widespread population. Online course delivery is a valuable alternative to on-campus enrollment for many of the rural students in our state. *Introduction to the Flora of Alaska* and *Systematic Botany* are now being offered as fully online courses with a lab component. These courses taught both online, and in the classroom (COVID-19 depending), are versions of the first author's own experiences taking these same classes taught by Don Pinkava at Arizona State University. His legacy as an intrepid botanist and inspiring educator influenced how I (Steffi Ickert-Bond) approached developing my own teaching style. The course design presented reflects some of Don Pinkava's rigorous detailed and challenging course content and innovative labs. The devoted teacher he was, Dr. Pinkava left for us a comprehensive statement outlining his teaching principles he had acquired over many years (Appendix 1). As a student of Don's, I have applied those teaching principles to my own courses. To create a lab experience like Don's classes, I have carefully chosen technology that will allow students from all over the state (and even outside Alaska) to have a hands-on learning experience. Using cutting-edge virtual herbaria they collect data, and perform plant dissections within the flora's native environment. Instead of traditional course materials like textbooks, students use an inexpensive wide-angle macro lens to take high-resolution, detailed photos of flora on the go. The technology not only lets students mimic lab spaces in their own areas but also expands their digital networks through the submission of images to iNaturalist, enabling them to share and collaborate with enthusiasts around the world. Students must get outside, touch with their hands and share what they discover. In combining traditional methods with modern technologies such as virtual, streaming dissections students develop skills and confidence with the microscope and dissection techniques just as much as I did in Don's in person *Flora of Arizona class* in 1993. Today the *Introduction to the Flora of Alaska* (BIOL190), and *Systematic Botany* (BIOL331) are both exciting intersections highlighting a curiosity for wild plants, an exploration of Alaska's plant communities as well as a great introduction to the science of botany. Don's *Flora of Arizona* took us students to those same crossroads. Together with my colleague Dr. Ute Kaden who teaches STEM methodology at the School of Education, UAF we describe effective course design elements for online delivery of a biology course and the challenges that come with it. Some student feedback after the first semester running will be presented here as well.

RESUMEN

Alaska está relativamente aislada del resto de los Estados Unidos, debido a su distancia, tamaño y población extendida. La entrega de cursos en línea es una alternativa valiosa a la inscripción en el campus para muchos de los estudiantes rurales de nuestro estado. *Introducción a la Flora de Alaska* y *Botánica Sistemática* ahora se ofrecen como cursos completamente en línea con un componente de laboratorio. Estos cursos impartidos tanto en línea como en el aula (dependiendo de COVID-19), son versiones de las propias experiencias del primer autor al tomar estas mismas clases impartidas por Don Pinkava en la Universidad Estatal de Arizona. Su legado como botánico intrépido y educador inspirador influyó en cómo yo (Steffi Ickert-Bond) abordé el desarrollo de mi propio estilo de enseñanza. El diseño del curso presentado refleja algunos de los contenidos rigurosos, detallados y desafiantes del curso y los laboratorios innovadores de Don Pinkava. El devoto maestro que fue, el Dr. Pinkava nos dejó una declaración completa que describe los principios de enseñanza que había adquirido durante muchos años (Apéndice 1). Como estudiante de Don, he aplicado esos principios de enseñanza a mis propios cursos. Para crear una experiencia de laboratorio como las clases de Don, he elegido cuidadosamente la tecnología que permitirá a los estudiantes de todo el estado (e incluso fuera de Alaska) tener una experiencia de aprendizaje práctica. Utilizando herbarios virtuales de última generación, recopilan datos y realizan disecciones de plantas dentro del entorno nativo de la flora. En lugar de los materiales tradicionales del curso, como los libros de texto, los estudiantes usan una lente macro gran angular económica para tomar fotografías detalladas de alta resolución de la flora sobre la marcha. La tecnología no solo permite a los estudiantes imitar espacios de laboratorio en sus propias áreas, sino que también expande sus redes digitales mediante el envío de imágenes a iNaturalist, lo que les permite compartir y colaborar con entusiastas de todo el mundo. Los estudiantes deben salir, tocar con las manos y compartir lo que descubren. Al combinar métodos tradicionales con tecnologías modernas, como disecciones virtuales, los estudiantes desarrollan habilidades y confianza con el microscopio y las técnicas de

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disección tanto como lo hice en la clase presencial de *Flora de Arizona* de Don en 1993. Hoy en día, la *Introducción a la Flora de Alaska* (BIOL190) y *Systematic Botany* (BIOL331) son interesantes intersecciones que destacan la curiosidad por las plantas silvestres, una exploración de las comunidades de plantas de Alaska y una gran introducción a la ciencia de la botánica. Don's *Flora of Arizona* nos llevó a los estudiantes a esa misma encrucijada. Junto con mi colega, la Dra. Ute Kaden, quien enseña metodología STEM en la Facultad de Educación de la UAF, describimos elementos de diseño de cursos efectivos para la entrega en línea de un curso de biología y los desafíos que conlleva. Aquí también se presentarán algunos comentarios de los estudiantes después del primer semestre.

Key Words: systematic botany, asynchronous delivery, lab activities, learning glass, ThingLink platform, Don Pinkava

Alaska's state motto North to the Future was adopted in 1968 during the Alaska Purchase Centennial. The motto is meant to represent Alaska as a land of promise. Suggested by journalist Richard Peter who stated: "… is a reminder that beyond the horizon of urban clutter there is a Great Land beneath our flag that can provide a new tomorrow for this century's 'huddled masses yearning to be free'."

Don Pinkava Intrepid Botanist And Exceptional Teacher—Reflections by S. Ickert-Bond

Having been classically trained at The Ohio State University, Don combined the best traditions of T. Richard Fisher, Clara Weishaupt, Emanuel Rudolph, Bernard S. Meyer, and Richard Popham in his teaching at Arizona State University (ASU, see details in the DeVore and Pigg contribution). As a student at ASU, taking his *Flora of Arizona*, *Angiosperm Taxonomy* and *Cytogenetics* courses was foundational for my understanding of systematic botany. Indeed, one of Don Pinkava's greatest legacies was as an educator. His teaching was rigorous, challenging and demanding. As students and teaching assistants we learned much from "what he taught, and how he taught" (Keil et al. 2018). When I served as his teaching assistant in 1994, he introduced me to the art of teaching (Fig. 1). However, it would not be for some years later that we would discover his teaching statement among his office belongings at ASU, in which Don articulated his teaching philosophy.

Dr. Pinkava was my role model as a teacher and his enthusiasm and passion for botany was infectious. Dr. David Keil (2019), another former student of Don's, summarized Don's contribution to the teaching and mentoring of students by saying: "During his career he introduced thousands of students to the flora of Arizona. He was major professor, guide, and mentor to 33 graduate students, and after retirement his influence extended to many more. … Don's influence as a mentor and example extends through his many protégés who have increased his legacy in their own careers. He invested himself in his students and humbly but firmly expected excellence in return."

Dr. Pinkava's meticulous attention to detail in cytogenetics, his mastery of botanical terminology and nomenclature for revisionary systematics, and, above all, his love for field botany have inspired me to incorporate these components into my own teaching. His lectures were amazing revelations delivered in his calm, direct and sometimes humorous manner (Fig. 2).

He taught labs by the "old school" method, with students drawing, labeling, dissecting; struggling to relate the terminology to the actual structure under the microscope, and wondering how many terms for hair-like "trichomes" a person needed to know. To this day, I often look over my notes from 30 years ago to prepare for my own lectures, and it seems just like yesterday when I sat in the large auditorium at ASU alongside 120 other plant enthusiasts to take Don's legendary *Flora of Arizona* class. In this essay I will showcase the development of my two introductory biology courses (BIOL195 – *Introduction to Alaska Flora* and BIOL331—*Systematic Botany*) designed in an asynchronous online format. My course design, content and delivery have all been inspired by my first exposure to Don's *Flora of Arizona* course I took in 1993. Below I have outlined how I accomplished that with the tools that Dr. Pinkava provided me.

My own tenure-track teaching career started at the University of Alaska Fairbanks (UAF) in the Department of Biology and Wildlife in 2006. The flora of Alaska is very different from that of Arizona, so that was a bit of a challenge to learn the new plant assemblages, but colleagues at the herbarium of the University of Alaska Museum (ALA) have been wonderful in assisting me in this endeavor. I was also able to share Dr. Pinkava's teaching philosophy with my colleague Dr. Kaden, who teaches STEM methodology to future educators at the School of Education, UAF. We are both creating distance learning courses using Dr. Pinkava's methodology as guidance to engage students in learning.

Alaska comprises a very large area with scattered populations (Fig. 3) making online course delivery a valuable alternative to on-campus enrollment for in-state students. Alaska is relatively isolated from the rest of

COMMENTS ON TEACHING

1. TEACHING IS AN ART

Fig. 1. The title of Don's 1993 statement of teaching (Appendix 1).

Fig. 2. Cartoon from Don Pinkava's 1993 teaching statement (Appendix 1).

the US, thus online Alaska flora courses could be made available to those students at other universities who wish to learn about its unique flora. Online delivery has great potential for reaching students in remote locations, not only to deliver introductory biology content, but also to engage them in place-based exploration of botany. This intimate connection with plants from their home region may provide these remotely located students with the motivation to pursue STEM fields in their college years and subsequent professions.

OVERVIEW OF ONLINE COURSE DEVELOPMENT AND COURSE DESIGN

In the following paragraphs the design and best practices in asynchronous course delivery will be discussed using BIOL190 and BIOL331 as examples. Links to effective course elements will be provided. In these two courses a number of innovative elements for online teaching are used, including Learning Glass videos, Video Dissection of Flowers, Virtual Field trips, and a Virtual Herbarium tour.

I. BIOL190 Introduction to Alaska Flora.

The objectives of the "Intro to Alaska's Flora—BIOL190" are to introduce students to several aspects of Alaska's unique flora. The sequence of course content is based on Don's teaching statement to present simple

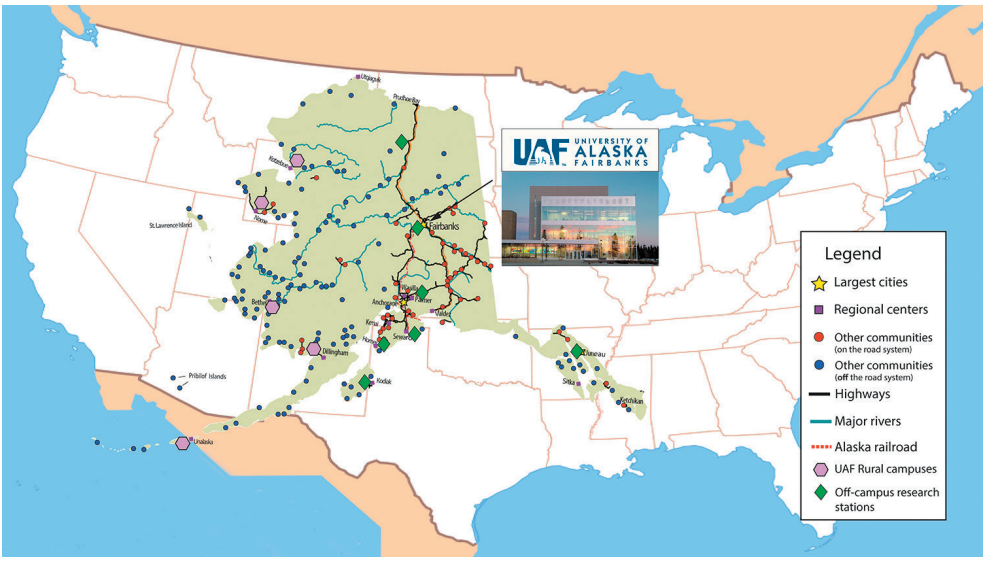

Fig. 3. Alaska map superimposed on the map of the United States showing its relative size. Main community centers are shown (in blue), the UAF main campus in Fairbanks and UAF rural campuses (in purple) and numerous research stations (in green) scattered throughout the state are indicated.

to more complex concepts as shown below (see Fig. 4). Class modules and hands-on exercises are designed to familiarize students with the identification, description, and morphology of the local flora of Alaska.

Students in BIOL190 will get familiar with the dissection of flowers, using technical keys, seeing scientific (Latinized) names, learn vocabulary that comes with describing and talking about plants, and curate images that they will take of the plants in their immediate surroundings. The course targets undergraduate students in biology at the University of Alaska, and is a required course for the Occupational Endorsement Certificate (OEC) in Ethnobotany, or counts as an elective for other sciences. This course can also be taken as a stand-alone course for members of the general public who are interested in botany and want to learn more about local plants and their identification, and participate in citizen science data collection. In addition, the course can be taken as professional development for science teachers and place-based educators.

BIOL190 (https://introtoflora.community.uaf.edu/) was designed in 2018 and offered as an asynchronous, online four-week course (2 credit hours). The course includes the delivery of content with integrated laboratory activities. From a general understanding of botany, the course also explores application of these concepts in a place-based framework, which was interpreted focusing on local flora and collecting original data and samples from the place where students reside. A greater appreciation of the history of place, environmental stewardship and use of plants were also included in the design. Over the years teaching botany, I have learned that students very much appreciate bringing botany back to them in a way that relates to their own lives. My course design includes engaging, place-based assignments like Plant Bingo, and Grocery Botany, where students discuss their grocery list in terms of fruits and plant families they purchase.

Making a leap into an online course for an organismal biology course, it was really important to me not to lose the visual aspect of the course. An online microscopy session during the identification of plants can be just as interactive as having a student working on a microscope in the lab where I can be looking over their shoulder. The overall course design was guided by best practices of online design which focuses on student engagement, community building (Martin et al. 2019) and integrating modern technology to present content and integrate labs. Botanists have to look at real plants (Fig. 5), and the expertise can be communicated over

10. BE AN EDUCATOR.

a. Begin with the familiar. Start the course with materials most familiar to students and work toward the least familiar. This may be contrary to the order in the text.

b. In general, going from simple to complex is usually a wise policy.

Fig. 4. "Be an educator" from Don Pinkava's 1993 Statement of Teaching (Appendix 1).

c. Use "hands-on" examples. Examples presented in class/labs/field trips should be hands on and as close as possible to the real object or organism. The more abstract the presentation (from the use of movie films to photographs, to drawing or charts, to lecture, to writings, in that order) the less comprehensible it becomes and the more varied are the understandings of the different students.

Fig. 5. This quote from Don Pinkava's 1993 teaching statement (Appendix 1) illustrates Don's uncanny ability to understand the importance of having hands-on experience both in the laboratory and in the field for learning botany and plant identification. It was these same field trips I participated in (Flora of Arizona) at ASU, that I was able to incorporate into my asynchronous course design of *Introduction to the Flora of Alaska.*

distance. Below I will discuss some innovative course elements that illustrate how this can be accomplished in the online environment.

Innovative Course Elements BIOL190

1. Learning Glass Video Lectures.—The 'Learning Glass', sometimes called a Lightboard, is a large piece of glass ringed by LED lights (https://revolutionlightboards.com/, accessed 4 May 2022). When fluorescent marker is applied to the surface, the ink catches the light from the LEDs and glows clearly and brightly. Instructors can take advantage of this and draw from behind the glass, allowing the audience to see them and their written work at the same time. A Learning Glass video collapses the perspectives of viewer and presenter into one shared perspective. You watch the presenter's face and body language while looking at the content they are creating. Students like it because they are watching a real person communicating to them, while getting visual and textual reinforcement of the content. Instructors like it because it allows them to communicate in a direct and natural way, while putting forth their best self to the students.

General content knowledge was delivered through guided reading assignments supported by instructor-made Learning Glass Video Lectures (Fig. 6, https://media.uaf.edu/media/t/0_t02o0m23). These lectures guide students through drawing botanical structures by providing visual examples of the instructor dissecting plants. Students are essentially "looking over my shoulder" as I demonstrate the dissection, and can be watched repeatedly until everything is understood. This technique shows students how to detect the relevant, focal structures from what may sometimes seem like "noise" under the microscope with so many cells, stains or dyes, and diverse parts. This is akin to the older style of drawing on a chalkboard, of which Don Pinkava was a master. The Learning Glass lectures has the advantage of allowing students to watch as I draw without

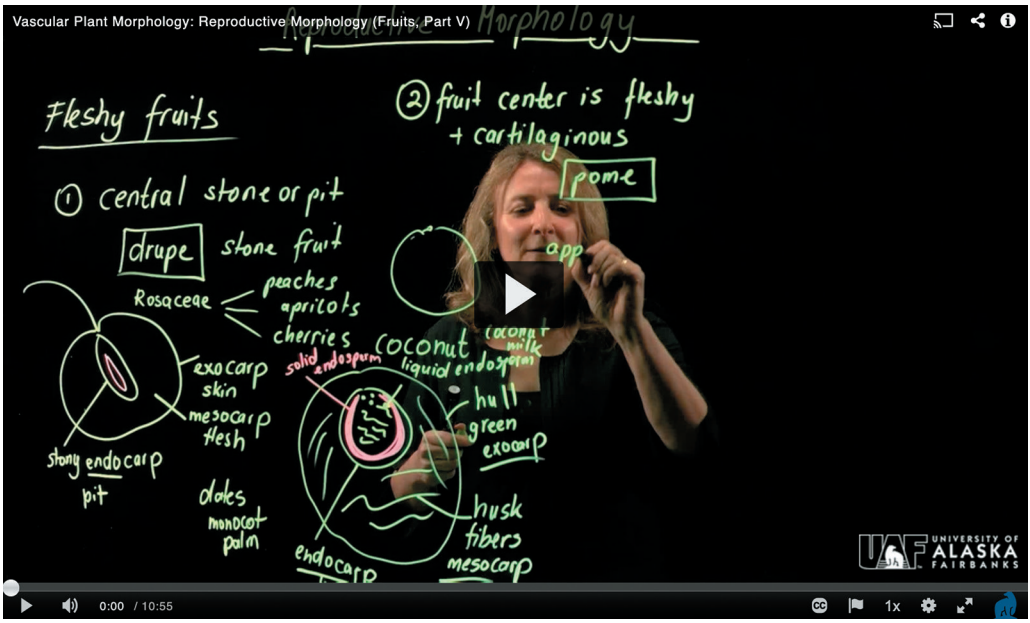

Fig. 6. Learning Glass video on reproductive morphology (Fruits, Part V). Viewable at https://media.uaf.edu/media/t/0_t02o0m23, accessed 20 March 2022.

my body being in the way. Because the lectures are recorded, students can also re-watch content at any time, with closed captions provided.

2. Video dissection of flowers (Fig. 7).—The hallmark of any botany lab is to look at plant diversity and dissect plants to see anatomical features (e.g., wood anatomy, stelar anatomy, leaf venation, and epidermal features). Furthermore, characters of taxonomic importance based on the examination of floral dissection are used for classification purposes (e.g., placentation, number and fusion of floral structures, and fruit morphology). For the in-person labs students would have fresh material at their disposal and would learn about plant diversity through discovery as they dissect the flowers, cones, strobili and see the varieties of forms and functions. The video dissections create that same sense of discovery for the students in the BIOL190 class. Students will then prepare their own dissections for the final project at the end of the class. Preparing their own dissection, photographing the pertinent structures and creating accessible, visually rich learning experiences in the ThingLink platform allows students to become fluent in using multiple forms of media to express themselves and share with their classmates. ThingLink (https://www.thinglink.com/en-us/ accessed 4 May, 2022) is an education technology platform that makes it easy to augment images, videos, and virtual tours with additional information and links. The ThingLink platform enables students to explain the structures observed from their dissected flowers and reflect on their progress towards achieving the intended learning outcomes (see also *Assessment of Learning* below).

3. Virtual Field Trip.—I have created virtual field trips, where students examine a 360° photograph that is linked to Google Maps in order to learn about Alaska's biomes.

II. Systematic Botany BIOL331

After the initial successful implementation of the online BIOL190 *Introduction the Flora of Alaska*, a second course was developed under similar guiding principles entitled *Systematic Botany - BIOL331* in response to the COVID-19 pandemic in spring 2019. It was modified from a preexisting in person version of Systematic Botany and is structured around engaging students in systematic botany to understand plant identification

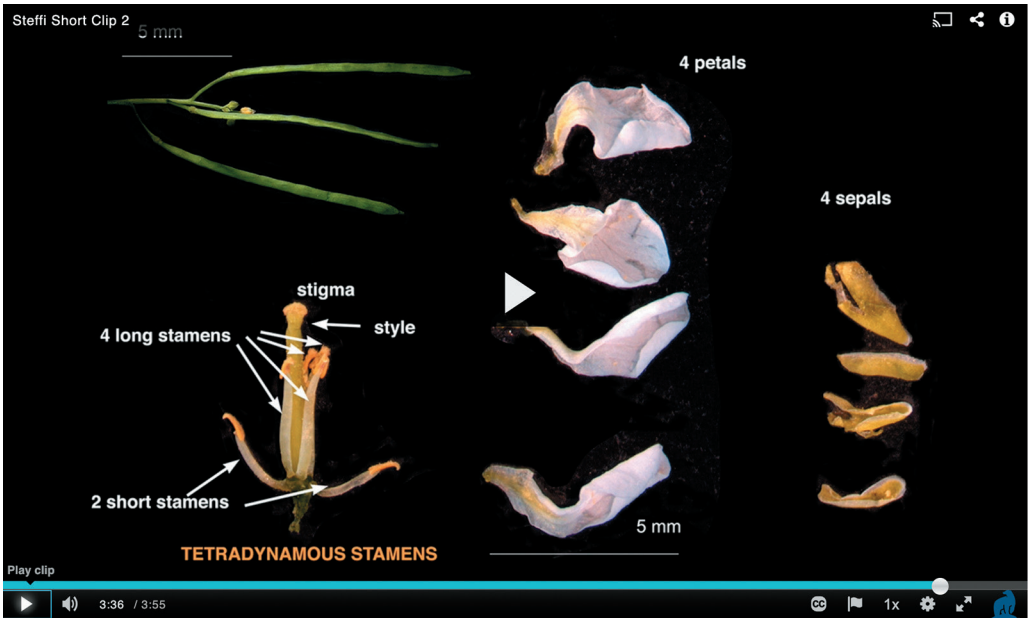

Fig. 7. Video dissection of *Arabidopsis kamchatica* (Fisch. ex DC.) K. Shimizu & Kudoh viewable at https://media.uaf.edu/media/t/0_57f27e32, accessed 20 March 2022.

through observation and descriptions of vegetative and reproductive morphology. The students will learn how to discover and classify plant diversity, describe and explain major features and evolutionary origins of vascular plants, and how to interpret and evaluate the analytical and experimental tools used to understand organismal plant diversity. For the lab the students will learn to use and apply the vocabulary of plant description, learn to identify plants using dichotomous keys, and recognize the major fern and fern ally, gymnosperm and angiosperm families in Alaska. The students will also learn to document plant observation for scientific study, and curate images that they will take of the plants in their immediate surroundings using the citizen science app *iNaturalist*. It is an elective course for biology undergraduate majors, and a required course for Wildlife and Conservation majors in biology. Student feedback after the initial delivery of BIOL190 was collected, analyzed and course design was adjusted. It is important to note that the course design is not static, it uses feedback for improvement. The course includes additional learning innovations and elements.

Innovative Course Elements BIOL331

1. Virtual Herbarium tour.—For the lab section of the course, I developed a virtual herbarium tour in the online annotation platform ThingLink. The landing page of the virtual herbarium uses the floor plan of the University of Alaska Museum with the specimen range in the center (Fig. 8).

I simulated the organization of the aisles filled with herbarium cabinets following the phylogeny of green plants (One Thousand Plant Transcriptomes Initiative 2019). Students can explore herbarium specimen images in cabinets that are organized following the Angiosperm Phylogeny Working Group III (2009) by order and family (Fig. 9). Within the cabinets the specimens are recoverable by their scientific names. The call-out buttons (plus icons) take the student to the annotated specimen image. Each of the specimens are annotated with key characteristics and microphotographic images to enable students to key out these plants (Figs. 9–10).

Just as we used dichotomous keys in Dr. Pinkava's *Flora of Arizona* class to key out unknown fresh specimens each week in lab, here in the online environment, students will visit a quiz cabinet (Fig. 10A) that shows

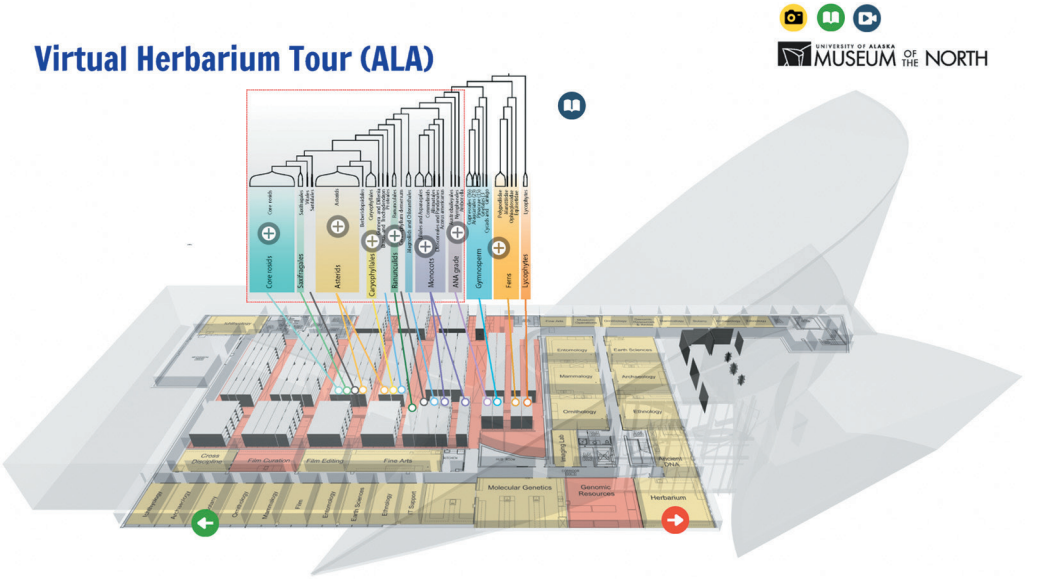

Fig. 8. Landing page of the virtual herbarium tour (ALA) created for BIOL331 in 2021. This open content is accessible at www.thinglink.com/scene/1406090479749038081, accessed 22 March 2022.

Fig. 9. **A.** Apiales cabinet showing the call-out buttons for each of the specimens students can explore. If you hover over the call-out button a small thumbnail image and the scientific name of the specimen appears. On the left the families included in the Apiales based on APG III are shown, with the ones occurring in the Flora of Alaska highlighted. **B.** Clicking on the call-out button will take the student to the specific herbarium specimen image. **C.** Habit shot of *Oplopanax horridus* (Sm.) Miq. as part of one of the call-out buttons. This open content is accessible at https://www.thinglink.com/scene/1428075703928094722, accessed 22 March 2022.

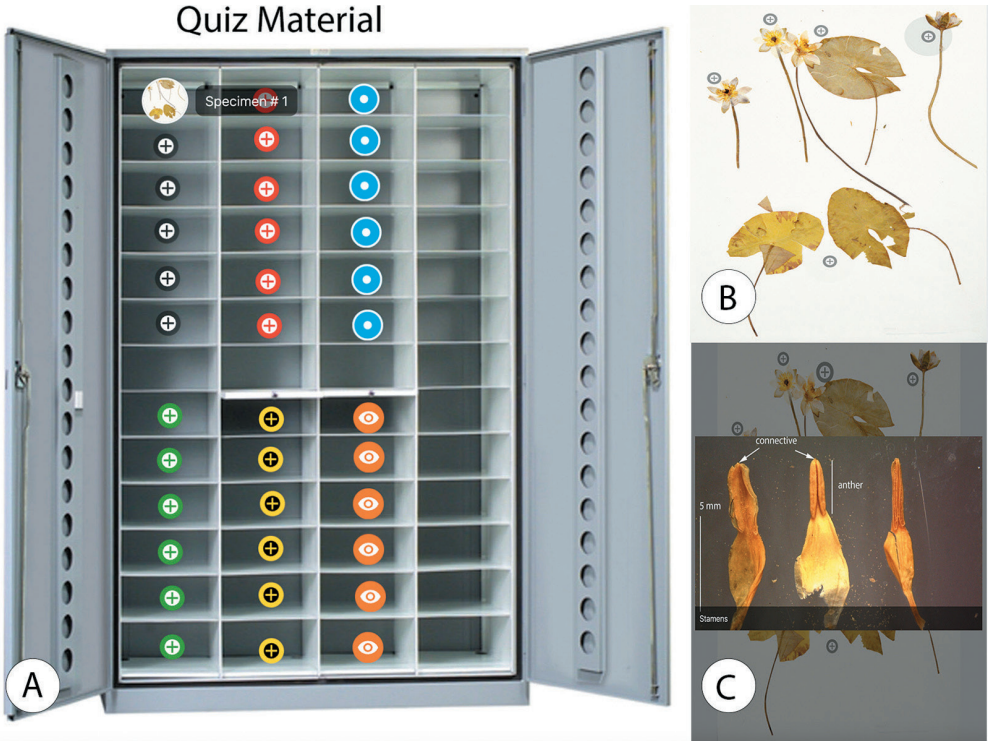

Fig. 10. Quiz cabinet. A. Quiz cabinet showing different colored call-out buttons indicating six different weeks with six specimens to key out each week. B. Specimen 1 image showing call-out buttons on several important characters of taxonomic utility. C. Call-out button showing features of the stamens of this specimen.

herbarium sheets (Fig. 10B) with call-out points showing images of particular characters needed to key out the specimen in question (Fig. 10C).

2. Gymnosperm life cycle group project.—The course design included group assignments to assess learning and to build community. Students worked in groups to record a video on the gymnosperm life cycle using a Power Point presentation, visual aids and a voice over. Following one of the seven principles of learning, learning is enhanced through socially supported interactions (Uno 2009). The group project provides students with opportunities to exchange ideas and discuss them with others. They can gauge their understanding of concepts and these group assignments capitalize on the sociality of students.

STUDENT FEEDBACK

Feedback in course evaluations was received from 60 students enrolled in the courses (BIOL190 and BIOL331) during the first year to inform course design and measure learning outcomes. 92 % of students rated the assessments *Review of life cycle videos*, and *Floral Dissections* as highly effective. To inform course design and measure learning outcomes we analyzed data from written student course valuations, pre- and post-tests, and open-ended course survey questions (Table 1).

Summary of *Highly rated* course elements by students (see Table 1)

- Stunning Visuals (95%)
- Clear course design and assessments (90%)
- Teacher is present and visible in learning glass lectures, which gives a personalized touch to learning and is highly motivating (91%)

- Hands on approach to dissections that is also demonstrated and modeled by the instructor is engaging (88%)
- The use of local flora is inspiring and motivating to learning about where we live (86%).

Table 1. Course elements which were rated the highest and contributed most to learning based on student feedback.

iNaturalist observation assignment.—"Having the opportunity to seek out new specimens and try to ID them each week helped me learn about the diversity of plants found in Interior Alaska." "After the class ended, I got inspired to continue making observations in Alaska."
Learning glass video lectures.—"Course-specific learning glass videos were engaging, of high quality, had the right length, made the course more personal with the teacher present in the home." "I loved the learning glass videos that you gave. It really helped me visualize the content." "I loved the learning glass videos. I think that piece of technology is such a gift for distance learning lectures." "The learning glass videos made me feel the most like I was in class because you were actively teaching and writing things out so I could follow what you were doing and putting it together while I actively took notes with you."
Professionally-delivered live video dissections of local flora.—"Learning how even the small flowers and hidden ones have such amazing activity and structure going on inside, like the big flowers, was amazing." "I also liked the dissections."
Virtual reality videos underscore the place-based elements of the class.—"As a student I got encouraged to look for additional examples of collections and research objects in my immediate surroundings." "No more plant blindness!"
Community building as part of the course design provided learning success.—"I really enjoyed the group projects, learning the life cycles of plants I have always struggled with, but doing it in a group project I was able to understand the cycles better than I have ever before."
For the laboratory experiences students could use the capabilities of their handheld devices e.g., smartphones, tablets for documenting their dissections and collections and guidance was given to add additional capabilities by using macro-lenses to their smartphones or tablets.—"I liked getting off my behind, going outside, & exploring the world around me to get assignments done. I also liked using new tools (macro lens and iPhone) to look closer at the world around me."
Participating fun and intellectual stimulating.—"Professor Ickert-Bond went above and beyond with the presentation and organization of course content. She made learning the content interactive, engaging, and fun." "I'm so excited to ID plants this summer!" "I would recommend this course to absolutely anyone interested in Botany. This was the best online course I have ever taken and I really appreciate the time and thought that went into designing this class for online asynchronous delivery."
Weekly journaling assignments.—"I really enjoyed the journaling assignments. Every week I would be dragging my feet on getting assignments turned in, but once I started sketching it pulled me out of that mindset and I'd get everything else done in a timely manner."

Examples of learning assessments

1. Floral dissections.—Students are introduced to floral dissections by professionally-delivered live video dissections of local flora (see *2. Video dissection of flowers*). As part of the self-learning process students in BIOL190 dissect flowers and upload images of their dissections to the ThingLink platform where they can annotate their images, making the images interactive (Fig. 11). For this and many other activities I have created a virtual space where students can see the work submitted by their classmates, creating a sense of community. This aspect of online teaching is sometimes hard to achieve even when teaching in-person courses. I provide personalized and extensive feedback to help each student progress in their development (Fig. 12).

UAF Instructor (pers. comm., 2022): "The quality of instruction became immediately visible when students who had BIOL190 *Introduction to the Flora of Alaska* joined the EBOT100 *Ethnobotany Field Course* class; these students could easily be distinguished by having a reliable basis of skills and knowledge about plant identification in general and plants of Alaska. Students who took the online course BIOL190 usually stand out by showing well-founded confidence in their skills as well as their high motivation to learn more about plants, plant-sciences and related academic fields."

UAF student, course participant (pers. comm., 2021): "For one lab assignment in BIOL331, we had to identify and collect native plants in the winter around the Fairbanks area. We brought these specimens into the museum and took the most amazing photos of their winter leaf buds. The detail I observed on something the size of a pencil tip was unfathomable! This classroom experience was a genuine intersection of art and science that really spoke to my spirit. As a result, I often find myself taking zoomed in photos of plants everywhere I go in Alaska. Second, Dr. Ickert-Bond introduced me to the citizen science program known as *iNaturalist*, which has given me additional opportunities to contribute outside the classroom. *iNaturalist* is a free,

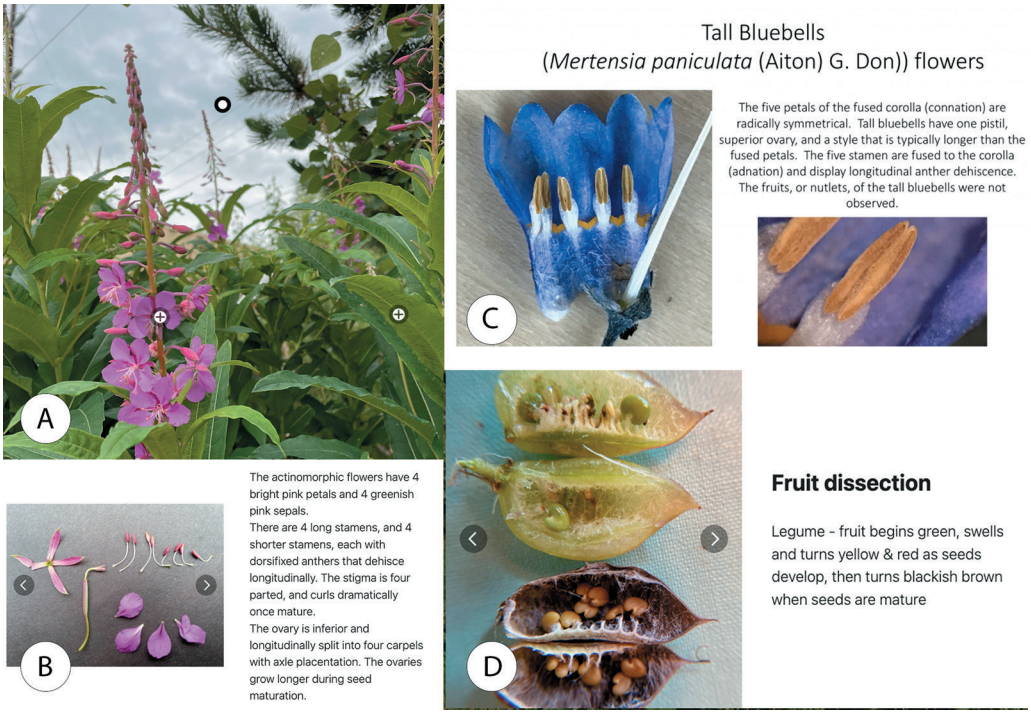

Fig. 11. Examples of student dissections. A. Dissection of fireweed (*Chamerion angustifolium* (L.) Scop.) using the ThingLink platform with call-out buttons. B. Details of the flower dissections and text describing the floral parts. C. Dissection of tall bluebell (*Mertensiana paniculata* (Aiton) G. Don) submitted as images on the WordPress website. D. Dissection of Canadian milkvetch (*Astragalus canadensis* L.) showing a call-out button for the fruit dissection from ThingLink.

open-access internet website that allows individuals to observe, identify, and document the diversity of all life anywhere in the world. Since being introduced to *iNaturalist* in this class, I have made over 1000 observations across Alaska. These observations help scientists better understand the distribution, abundance, and phenology of life all across Alaska. The sense of adding to the general understanding of life in Alaska makes me proud and is something I look forward to doing well into the future."

RECOMMENDATIONS

Recently, Biology departments across the United States (and beyond) have started to increase accessibility of course content for biology, genetics, and other life science courses. Especially in response to the COVID-19 pandemic, colleges and universities were forced to transition in-person instruction to new modalities of remote teaching. As a result, online learning became more acceptable and quality online teaching will be here to stay as part of the general course delivery at most universities and institutions of higher learning (Auffret et al. 2022). However, we also learned that there is no quick, easy, or cheap way to designing effective online courses.

After thoughts and lessons learned.—Online course design takes time, skills, and a good support structure from the institution. We are fortunate at the University of Alaska Fairbanks (UAF), that eCampus instructional designers are excited to team up with faculty and collaborate to develop innovative course design, and educational materials that adhere to pedagogical principles of open access and equality for all students. Overall, we are given numerous opportunities for professional development to advance our course offerings

These are gorgeous Oonal! Great job on using ThingLink and describing and dissecting the flowers. The bunchberry has a hypanthium that is the result of fusion of sepals (which turn darkish red to purple at maturity), petals (white) and stamens. The Hypanthium has densely appressed hairs which you show nicely on your images. The fruit is a drupe (stony endocarp). If it were a nut, the whole pericarp would be stony (the mesocarp is fleshy in Cornus) and we need to have an involucre subtending each fruit, which is lacking here as well. Great you were able to capture the details of the anther filaments in the woolly geranium, it is fun to watch when the solitary seeds flung out when the carpel suddenly splits. For Polemonium, I would not describe it as having a hypanthium, by definition a hypanthium is the fusion of sepals, petals and stamens. In Polemonium you can clearly find the sepals fused into a ring (synsepalous) and a ring of petals fused (sympetalous) with the stamens adnate to the corolla (epipetalous). The ovary is free from either one of those rings, and each is inserted below the ovary, thus hypogynous. I think the base of the ovary and the base of the calyx perhaps appear fused due to the common stem base they are inserted on. Your photography is excellent, and it shows your command of the characters that are important for identification. I hope you enjoyed making these dissections. It sounds like you are very well versed in botanical jargon now :). If you are continuing to observe flowers, try to make some dissections of the ovaries in both cross section and longitudinal section. It is fun to see the placentation types this way. Fabulous work, so proud of you!

Fig. 12. Example of student feedback on the WordPress class website.

with unique content at UAF. The most challenging in this process has been the time commitment on top of the day-to-day responsibilities as a faculty member, which seems to be always underestimated. The administration should provide financial support and training for faculty tasked with designing online learning or changing delivery from face-to face to online modalities. Peer-review, we have received from students and most importantly from professional colleagues on the quality of our course design, delivery, and visual elements have been hugely encouraging. Detailed guidance for some faculty might be needed to transmit knowledge in the online environment. Students have commented positively on timely student feedback during our courses, and have enjoyed group activities and elements of applying the knowledge in a local context.

APPENDIX 1

D.J. Pinkava. 1997. Comments on Teaching. Unpublished.

1. TEACHING IS AN ART.
2. CONSIDER YOUR STYLE(S). There is no one way to teach. A varied-patterns approach seems profitable. The teacher should adapt to changes – avoid being in a rut. The course should evolve as new materials are published and techniques made available. Certainly beginning courses are taught differently from advanced courses and from graduate courses, seminars and research.
3. BE ORGANIZED. Determine main principles (themes or concepts) to be covered in the class. These principles should intertwine and support one another. The course should build on itself during the semester. Facts and terms should be continually incorporated into new problems presented throughout the course. At the beginning, cite the objectives of the course. Also cite the mechanics of the course (assignments, testing, grading, etc.). Students need to know what is expected of them. An historical perspective (for whole course or for each of its parts) provides background for the students.
4. BE HONEST. Do what you say you will do. Keep schedules you have promised as best possible.
5. BE FAIR. Treat all students in a class the same. Do not favor some students over others. Show compassion to those with special needs. Do not embarrass or ridicule a student or make fun of anyone or his/her work.
6. BE PATIENT. Ideas take time to evolve.
7. BE ENTHUSIASTIC. Enthusiasm is 90+% of teaching. Unfortunately, I know of one professor who fell asleep in his own lecture.
8. BE DILIGENT. Teaching requires time and effort. Do not rely solely on your memory; prepare anew each time. Complacency drains life from both teacher and student. First-time teaching of a course is demanding and much time is needed for preparation and delivery. Repeatedly teaching a course allows not only for improving the presentation and methodology, but also provides more time for student-teacher interaction. Being more at ease with the subject matter increases the fun of teaching.
9. BE AWARE. A lot of teaching is not formal; it may not even be directly related to teaching matter. Set an example students can follow. Be organized. Start and end on time. Use proper grammar and spelling. In smaller classes encourage the best in written materials, such as writing in a style for publication.
10. BE AN EDUCATOR.
    a. Begin with the familiar. Start the course with materials most familiar to students and work toward the least familiar. This may be contrary to the order in the text.
    b. In general, going from simple to complex is usually a wise policy.
    c. Use "hands-on" examples. Examples presented in class/labs/field trips should be hands on and as close as possible to the real object or organism. The more abstract the presentation (from the use of movie films to photographs, to drawing or charts, to lecture, to writings, in that order) the less comprehensible it becomes and the more varied are the understandings of the different students.
    d. Keep attention focused. Using the "pause" is effective in getting everyone's attention before starting session or at time when students aren't paying attention – the teacher's silence is upsetting to students. Require mutual respect among students so that no student infringes on the rights of others to learn.
    e. Allow for questions. Calling for question at the beginning of each class at least assures them of the opportunity. No sincere question should be left unanswered. If a student asks questions wherein it requires much time to answer (essentially redoing major parts of the class), ask him/her (and anyone else with similar difficulty) to come in during office hours. If the student asks a question that you can't answer immediately then you have options, e.g.: 1) offer to find an answer to the question; and then do it. 2) if it is beyond the scope of the course, recommend some readings for the student to pursue the answer. 3) Can anyone here (classroom) answer the question? 4) how could you set up an experiment to find the answer?
    f. Evaluate. Testing should be a learning experience for the student. Some direct recall questions are OK, but regurgitation on an exam is fruitless – you're not finding out if he can think or even really understands what he's regurgitating. Require the students to put two to several facts together to answer a question, an answer the student may not have thought about earlier. Having student set up an experiment(s) to seek answers to a problem is effective. Editing a passage that contains errors (particularly if from a text or newspaper clipping) is insightful. Modify true-false questions into statements that are either true (marked as true) or false (they must modify certain words in the statement to make it true). Provide a description of an organism using technical terms and ask them to provide a labeled drawing; or to graph provided experiment data; or ask them to interpret graphic data.

       Evaluation of students is the most difficult phase of teaching. Size of class often dictates type of questioning, ranging from multiple choice to short answer to essay to oral exams. In larger classes one might try grading on improvement/deprovement basis – steady improvement gets best grade at the end of class or steady deprovement gets lowest grade at the end; encourages slow starters but keeps pressure on good students.

g. Demand high standards. Extra credit is not warranted; it's a high school trick. The grade awarded a student reflects to the community that this is what the student knows compared to other students. Extra credit simply covers up a flaw in the performance. If more knowledge is necessary outside the classroom, then assign projects to all in the classroom to seek out information on a topic of their interest relevant to the class (and put limitations on its scope).

11. Maintain a sense of humor.

D.J. Pinkava 1997

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