In-Person or Online Learning Choice On-Demand: Easing into HyFlex with Existing Flipped Classroom Assignments

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Abstract

Hybrid-flexible, or "HyFlex," courses allow students to flexibly decide at any time during a course whether to attend in-person components or to opt for alternative online learning assignments designed to foster the same learning objectives. The challenge to the instructor is to offer and manage both in-person and online options simultaneously (in the same class section) with quality and sustainability. Engineering technology programs at Kansas State University Salina Aerospace and Technology Campus saw the opportunity to partner with industry internships and remote campus students through flexible course attendance options. HyFlex course delivery preserves existing campus strengths in in-person active learning while simultaneously offering online participation options. Flipped classroom assignments had previously been designed to support in-person learning, moving first-exposure instruction from the lecture classroom to guided assignments between class meetings. Because flipped classroom assignments were designed to guide students while away from the instructor, they were easily transferable to online-option students. Support materials initially developed for in-class problems-based and project-based activities were also easily adapted to support asynchronous learning. These resources proved ideal for a quick transition to support online option students in a HyFlex course. Case examples from the non-lab class meetings of three different first and second-year engineering technology courses illustrate (1) the original intent of flipped classroom and problem-based learning activities for the in-person-only class and (2) how they were translated into the HyFlex environment to meet the needs of synchronous and asynchronous learners.

Keywords

HyFlex, flipped classroom, hybrid learning, blended learning, engineering technology

Introduction

Experiential learning is a hallmark of Engineering Technology programs at Kansas State University Salina Aerospace and Technology Campus. Many students select the campus specifically for their emphasis and access to hands-on experience with industry-relevant equipment and projects. Students value the in-person experience. However, emerging opportunities to reach student groups with more flexible course attendance are pushing the program to offer more flexible attendance options:

- Local industries have requested partnerships to allow internship students to be away from campus certain days during the week in order to work their internship shifts.

- Industries at remote campuses are requesting online lecture access to engineering technology programs, with arrangements for labs on the remote campus.

Until such programs gain momentum, outreach to online students would have insufficient enrollment for separate course sections; these students must be absorbed into existing course sections. Hybrid-Flexible, or Hy-Flex, courses accommodate students who need online access alongside the in-person course experience. HyFlex methodologies usually accomplish the simultaneous online and in-person modalities in part by connecting online students to the in-person classroom via videoconferencing and recording technologies. HyFlex course design offers students the choice of in-person or online assignments, which may differ but lead to the same learning outcomes.

The first-year roll-out of HyFlex options for students in mechanical engineering technology courses demonstrated the ready adaptability of flipped classroom assignments and resources to online-option students.

Terminology

Terminology for In-Person, Online, and Blended Modalities. Terminology concerning online and in-person learning modalities can vary between practitioners and institutions. Options and flavors may vary according to program and community needs. Institutions form specific definitions for clarity at the time of course registration. For this discussion, strict specificity is not necessary to consider the general nature and opportunities of various teaching and learning modalities. We adopt the following general working definitions:

- **HyFlex Course (or Hybrid-Flexible Course)**
  - The student may choose between in-person or online options at any time in the course.
  - Theoretically, a true HyFlex course has 100% student choice. However, some institutions allow minor exceptions from student choice to accommodate special needs. For example, an instructor may be permitted to shift an in-person class meeting to an online-only alternative when the instructor is unavoidably unavailable in-person. In some cases, in-person testing might be arranged for students who would otherwise choose all online options. However, the overwhelming intent is for students to have near 100% choice.
- **Hybrid Course (or Blended Course)**
  - Some of the course is in-person, but some traditional in-person content is substituted by online course delivery and interaction.
  - Student choice is restricted or fixed ahead of time.
- **HyFlex/Hybrid (or Hybrid/Hyflex) Course**
  - HyFlex choice is available for a significant part of the course, but not 100%. Some aspects of the course may dictate in-person only or online only.
  - Engineering and Engineering Technology courses which offer HyFlex for the traditional “lecture” portion but which require in-person lab attendance fall into this category.

  - Note that some practitioners do not accept the label "HyFlex" on any course that is not 100% free student choice, in which case, this category would be part of the hybrid or blended category.

For a deeper look at various flavors and alternate terms associated with HyFlex courses, see the chapter "1.1 Beginnings: Where Does Hybrid-Flexible Come From" in Brian J. Beatty's free eBook *Hybrid-Flexible Course Design*. [1]

Principles of HyFlex Courses and Instructor Challenges

Brian Beatty is generally credited with originating the term "Hybrid-Flexible" and "HyFlex." His "Four Principles of HyFlex Course Design" [1] summarize key challenges to the instructor:

- **Learner Choice:** Provide meaningful alternative participation modes and enable students to choose between participation modes daily, weekly, or topically.
- **Equivalency:** Provide learning activities in all participation modes which lead to equivalent learning outcomes.
- **Reusability:** Utilize artifacts from learning activities in each participation mode as "learning objects' for all students.
- **Accessibility:** Equip students with technology skills and equitable access to all participation modes.

The obvious challenge to an instructor is to prepare and deliver one course section in two (or three) modalities: (1) for students choosing to attend the in-person class meeting and (2) for students electing to follow the online alternatives, which could be either asynchronous or synchronous online.

It is common practice for Hy-Flex instructors to make and post recordings of their in-person class sessions and possibly to offer them for live online (synchronous) participation for remote students. This is one example of the "Reusability" principle: the in-person class meeting is also used for asynchronous online students and "reused" or repurposed as a recording for asynchronous students. However, the "Accessibility" principle sometimes demands more creative thought to ensure that online students achieve equitable access to similar experiences that the in-person students have during the class. For classes in which in-person students participate in active learning teamwork and discussions, the asynchronous student may be left out without some alternative to achieve equitable access to activities toward the same learning outcomes. Even for remote students who attend synchronously, videoconferencing technology does not always effortlessly bring remote students into in-class activities. Thought and preparation is required to set up technology for ease of inclusion.

Another concern for accessibility and equivalency is ensuring that students who choose all-online options are not left isolated from the support of a learning community. One example is in CAD-based classes which provide scheduled in-person class time in the CAD lab. The instructor is in the room to assist students who run into CAD difficulties, but students can also consult with their neighbors for assistance. Students with connections to other students may also consult with their peers when they get stuck during homework time outside of class. Online students may have greater difficulty connecting with their fellow students if the instructor does not encourage and facilitate connections. Although some students like to work alone, connections with their peers can help keep students mutually encouraged and spurred to timely activity. Instructors will use various means to connect online students with their peers. Common techniques include individual student introductions, team activities, discussion boards, shared document assignments, etc.

Some of the extra preparation which may be required by an instructor teaching HyFlex includes:

- Providing asynchronous options with self-guided resources and self-guided learning activities to compensate for lack of time in-person with ready instructor guidance.
- Providing clear instructions for options (in-person, synchronous, asynchronous).
- Ensuring engagement for students in multiple modalities.
- Ensuring formative feedback for students in multiple modalities (with particular attention to online students who may miss formative feedback from interaction with the instructor during in-person class meetings, if that applies).
- Arrangements for assessments.
- Extending flexible instructor-student interactions outside of scheduled class meetings.

A Foundation of Problem-Based Learning and Flipped Classroom Learning Assignments

"Flipped classroom" teaching techniques provide tools to assist students in gaining first-exposure to topics outside of class so that the "lecture time" with the instructor and learning community can be spent on higher-level thinking and concepts. In some ways it sounds like the classical tradition of expecting students to read the textbook or other materials before coming to class. However, robust flipped learning definitions at a minimum expect:

1. Individual preparatory assignments outside of class incorporate some sort of **direct instruction or guidance by the instructor.** Beyond students being given assigned reading, guidance might take the form of structured activities to help the student process the content.
2. The "lecture" time with the learning community (or equivalent) should support **an active, interactive learning environment supported by the guidance of the instructor.** [2]

Flipped classroom methods are often adopted to make room for problems-based learning (PrBL) or project-based learning (PBL) during in-person class meeting times.

This instructor's motivation for deploying flipped classroom techniques in engineering technology courses in the mid-2000s evolved from a desire to better-engage students during class meetings through problems-based learning. Although learning problems were given to students during class as an active learning approach, many students were inattentive during even brief lecture instructions necessary to introduce new approaches and concepts associated with the activity. By providing students with "InfoSheet" handouts summarizing key teaching points, student teams could be challenged to start new problems during class meetings without preparatory instruction. When students realized they needed more information, they could consult the InfoSheet as a guide at just the moment they needed it. Other teams might need the information sooner or later, so the InfoSheets allow teams to work at their own pace. Eventually questions come up for the instructor to address. Sometimes questions can be answered with an individual team. At other times the instructor can attempt to pause teamwork to host a discussion with all teams at a point when most of the teams are recognize that they are ready for new ideas.

Success with the InfoSheets and other guided worksheets demonstrated that case problems could be developed for first-exposure activities outside of class, leading to flipped classroom support and more time during the class meeting for more complex activities or application projects (project-based learning).

Because flipped classroom assignments and some problems-based or project-based learning assignments are accompanied by structured learning guidance, they have been easily adapted for online assignment options in HyFlex classes.

HyFlex Applications with Flipped Classroom Techniques in the Literature

The sudden need to offer instructional flexibility during the COVID-19 pandemic led instructors to quickly adapt to online and HyFlex offerings.

Dr. Paul Griesemer of the University of Mary Hardin-Baker provides an example of applying flipped classroom techniques to improve a HyFlex course offering. A Fall 2020 semester HyFlex Engineering Statics course began with traditional lectures offered in three modalities: in-person, synchronously online, or asynchronously. Disappointing student performance on the first exam caused the instructor to abandon the traditional lecture-based model in favor of a flipped classroom approach: Reading and viewing a pre-recorded lecture video became homework. In-person and synchronous students worked problems in teams using Zoom breakout rooms. Asynchronous students collaborated using discussion boards. Additional “mastery” problems were assigned following the in-class teamwork. Student engagement and performance increased with flipped-classroom techniques. Student opinions of the flipped classroom leaned positive but were mixed with concerns most frequently referencing groupwork challenges.[3]

Mechanical Engineering faculty at The Citadel (Washua, Bass, and Bierman) had already adopted flipped learning techniques prior to the COVID pandemic, then adapted them to HyFlex offerings to accommodate COVID social distancing protocols. Their paper discusses technologies adopted to share physical objects, sketching, and other facilitation of active-learning activities in the HyFlex flipped classroom. [4]

In 2022, Engineering Technology faculty from Tennessee Technological University and the University of Alabama Huntsville compiled flipped classroom course design strategies and observations from various manufacturing-related courses, all offered either HyFlex or online. Their courses leaned heavily on project-based learning during the classroom or classroom alternative portions of the course. Course design descriptions suggest a variety of methods to spur student preparation, activity, and collaboration which proved successful in engaging students. [5]

Examples of Flipped Classroom Self-Learning Activities and their HyFlex Transition

The following work extends the literature with examples of existing self-guided preparatory activities for flipped classroom support which proved readily adaptable to a HyFlex environment.

These HyFlex activities were rolled out for the first time in the academic year of fall 2023 through spring 2024. Only one student absolutely required online attendance due to an internship commitment, but additional students were supported to make their work arrangements more flexible, to handle childcare needs, or to save needless commutes of over an hour in length. In the fall 2024 semester, multiple students are taking advantage of HyFlex options to overcome course scheduling conflicts.

The Automated Manufacturing Systems I course and the Manufacturing Methods course both require in-person lab participation each week, with only lecture content offered as HyFlex. The Mechanical Detailing course had the option of 100% HyFlex with the exception of required in-person exams (though these could be scheduled at an alternate time with the instructor).

<u>Automated Manufacturing Systems I (First or Second Year)</u>

Existing Flipped Classroom Learning Activities and Resources:

- Some homework teaching videos and resources with self-check quizzes.
- Case example activity sheets developed for in-class team learning activities. These were later shifted to homework assignments to expand time for hands-on application activities during class meeting time.
- Textbook alternative: "Tooling U" commercial learning modules with learning quizzes; some supported with additional instructor-provided study guide questions, allowed as notes for use on exams.
- In-class learning is driven by 2 hours of lab activity per week. Teams of two are guided by a lab packet with the instructor available for additional guidance, checking, and feedback.

Adjustments for HyFlex/Hybrid Students:

- For the case example activity sheets, self-check quizzes have been created to assist with formative feedback in place of in-class review with the instructor. Students can do these activities individually or in teams of two. They may be part of the in-person lecture meeting or as an online alternative on their own time. Figure 1 demonstrates a case example activity sheet and its accompanying self-check quiz.

For this trial-run with HyFlex, one internship student out of 20 required HyFlex accommodation for two lecture meetings per week, but all students were given the option of performing the lecture activities asynchronously. Even the in-person students were encouraged to support each other in teams, consulting the instructor only as needed. Student performance was comparable with students in previous years who had an in-person-only course structure.

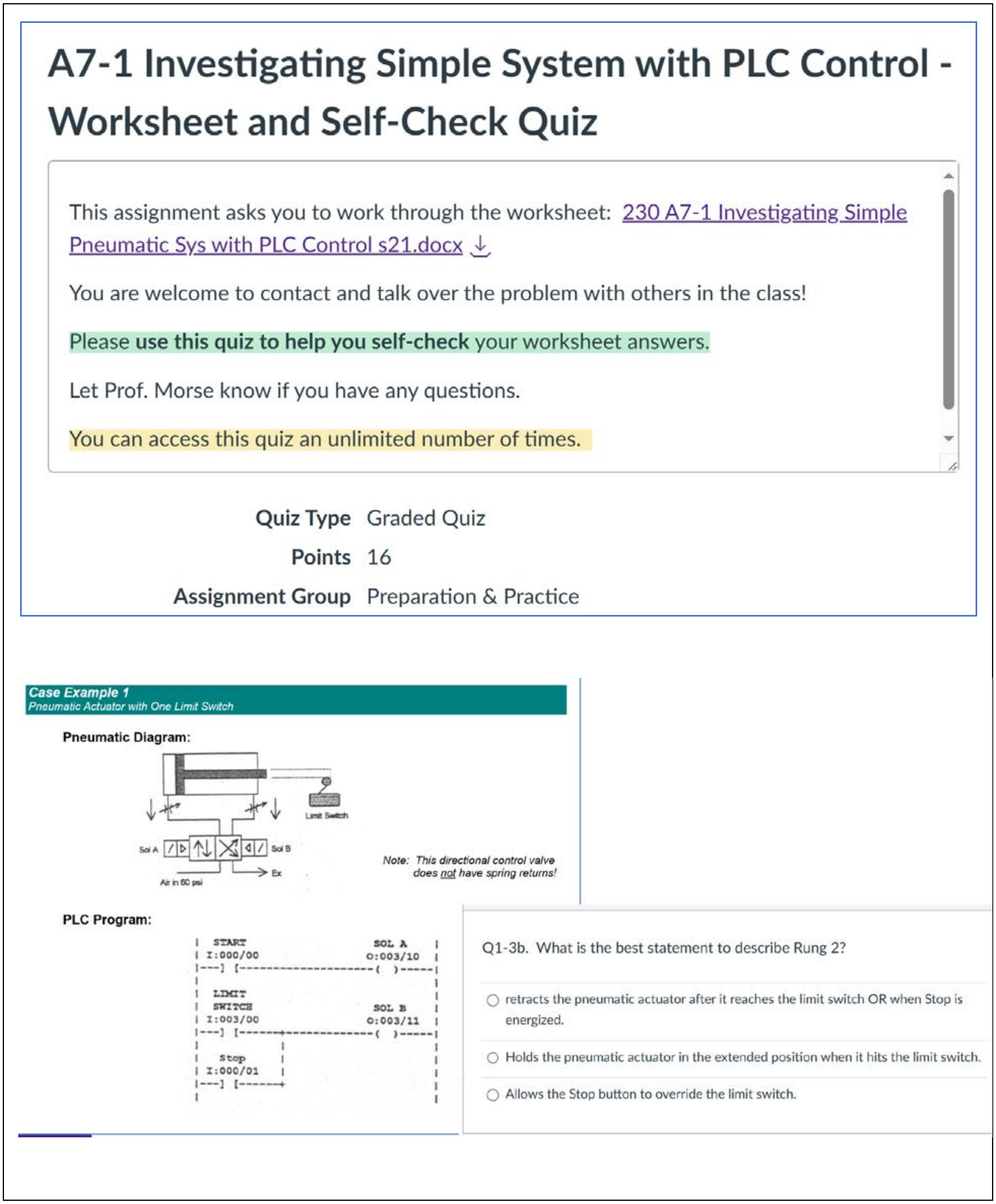

Figure 1. Example of flipped classroom self-learning case example activity for Automated Manufacturing Systems 1 course. Note that students have not seen PLC programs before this, but recognize that it looks similar to relay ladder diagrams. The quiz questions help them narrow down correct interpretation and check their hypotheses.

Course: Mechanical Modeling & Detailing (3D CAD) (First Year)

Existing Flipped Classroom Learning Activities and Resources:

- Students follow workbook CAD tutorials as homework. Self-check quizzes help students verify that they are meeting the learning objectives along the way, as demonstrated in Figure 2.
- In-person students work application problems during CAD lab hours, with the instructor present to answer questions and provide feedback on work. Students may spend additional homework time to complete application problems.
- Short instructor-developed teaching videos address tricky topics or frequently asked questions as they arise.

Adjustments for HyFlex Students:

- This course can be taken fully online (fully HyFlex) except for in-person or proctored exam arrangements. In-person lab attendance is not required (though encouraged).
- In-person teaching and discussion is extended synchronous/asynchronous via Zoom recordings.
    - The instructor manages the Zoom camera, microphone, and speakers to include online students in the experience.
    - The instructor arranges for synchronous online students to flag the instructor for Zoom screenshare assistance during open lab work. Alternatively, online students may email for assistance by appointment.
- Little change was required for assignments and resources.
    - Some arrangements were necessary for online student access or approval of real-life physical parts or measurements for some assignments.
    - Online students were carefully matched with design team partners according to their availability and collaboration resources.

Students who do not attend in-person for feedback are required to make an appointment with the instructor at least once every two weeks (either via Zoom or in-person) to review their work. Students who get behind may be asked to meet every week.

For this first-time offering of HyFlex, of 19 total students, one student with a childcare conflict attended online (synchronous one day a week, asynchronous the other). A second student with a long commute participated frequently through the online option. A third student started online as his choice method of learning, but he began to join in-person after some office-hours assistance and persuasion by the instructor to try the in-person option. All students were capable and successful. The opportunity to practice recording and integrating online students into the live student experience with just one or two students was helpful, as this takes some thought and practice with the technologies (both hardware and software).

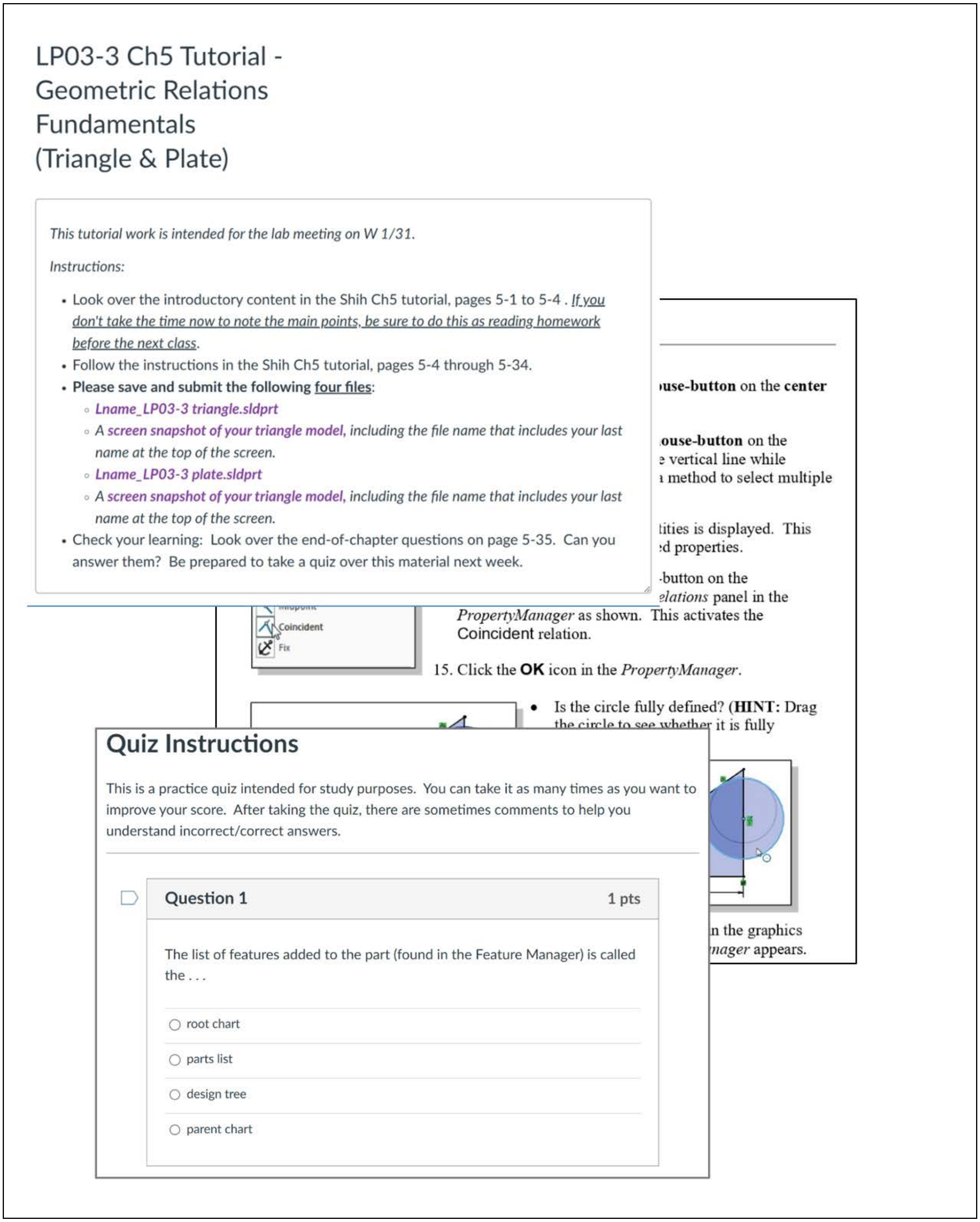

Figure 2. Example of flipped classroom tutorial with self-check quiz for the Mechanical Modeling & Detailing course. The quiz questions help students check that they have picked up on terminology and important procedures while following the tutorial examples and commentary.

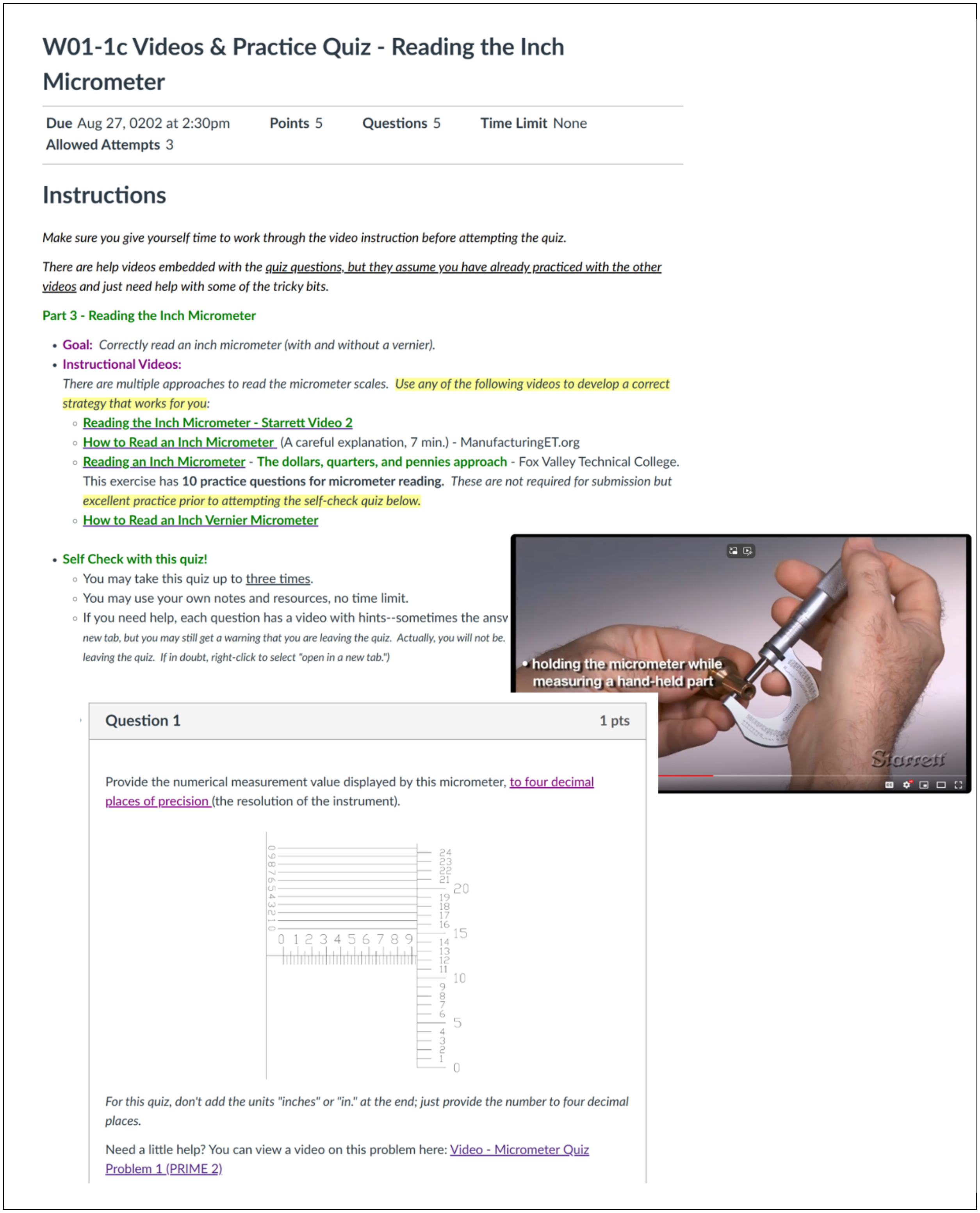

Figure 3. Example of flipped classroom teaching resource with self-check quiz for the Manufacturnig Methods course. Note that this quiz provides links to instructor-made videos of step-by-step solutions to each problem.

Course: Manufacturing Methods (First Year)

Existing Flipped Classroom Learning Activities and Resources:

- The textbook alternative, "Tooling U" commercial learning modules with learning quizzes, is designed for student self-study outside of class meetings, so ideal for supporting students in multiple modalities. Instructor-provided study guide questions lead students through important content. Students are allowed to use their completed study guides as notes for use on exams. This course relies on Tooling U modules to introduce the bulk of topics and equipment not encountered during lab activities and instruction.
- Additional teaching videos and resources are provided with worksheets and self-check quizzes. These address topics such as manufacturing measurement units and nomenclature, reading inspection instruments (micrometers, calipers), names of manufacturing equipment and their components (lathes, mills, etc.)
- One lecture hour per week provides opportunity for hands-on exploration (PrBL) and activities such as measurement instrument practice in small groups. For some topics, this time is used to deliver deeper content with video, photos, and discussion.
- Experiential learning is driven by four hours in the manufacturing lab per week.

Adjustments for HyFlex/Hybrid Students:

- This course has one credit hour lecture per week which is offered HyFlex. The two credit hours of lab (4 contact hours per week) has to be scheduled in-person, due to the need for access to various industrial processing and inspection equipment and trained instructional oversight.
- No adjustments were needed for teaching videos, quizzes, study guides, and Tooling U; these were already developed as homework assignments, appropriate for students in all HyFlex modalities.
- One hour of in-person lecture per week is provided synchronous and asynchronous via Zoom. There have been hurdles in improving and developing class activities (PBL/PrBL) appropriate for both in-person and online learning options. Some future online activity options may skip the Zoom recording for a more appropriate independent activity to meet the same learning objectives.

No students absolutely required the online option due to time conflicts, but it provided an advantage to one student whose internship was a one-hour drive from campus. In the fall of 2024, the online option allows two students to overcome a course conflict through online participation in the lecture.

Conclusions

The first year of offering HyFlex options to students demonstrated that previously-developed materials to support individual student preparation in the flipped classroom have proven ideal resources for supporting both online and in-person students in the HyFlex classroom. Additionally, resources built to support problems-based or project-based learning also required little supplement for online student use.

There were only one or two students regularly making use of the online alternative in this first-year experiment with HyFlex offerings, but these students all were successful in completing the learning outcomes with performance similar to their in-person classroom peers.

One element that requires additional development for online student support is formative assessments and self-checks for HyFlex students who are not available to interact with the instructor during in-person class meetings. More robust self-checks and efficient formative instructor interactions should be designed for independent learning activities.

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