GUIDELINES FOR TWO-YEAR COLLEGE PHYSICS PROGRAMS

2026 Edition

Editor-in-Chief

Sherry L. Savrda, Seminole State College of Florida, Sanford, FL (retired)

Editors

Dwain Desbien, Estrella Mountain Community College, Avondale, AZ

Kris Lui, OPTYCs/AAPT, College Park, MD

Working Group

Brian L. Lee, Sante Fe College, Gainesville, FL

Keith Madden, Ivy Tech Community College, South Bend, IN

Tony Musumba, Riverside City College, Riverside, CA

Jennifer Snyder, San Diego Mesa College, San Diego, CA

Brittney VornDick, Durham Technical Community College, Durham, NC

Reviewers

Michael Butros, H. Milton Stewart School of Industrial & Systems Engineering, Georgia Technological University, Atlanta, GA

Laura Romanovich, Johnson College, Scranton, PA

Elizabeth Schoene, South Seattle College, Seattle WA

INTRODUCTION

The American Association of Physics Teachers (AAPT) is actively committed to the support of high-quality physics education at the two-year college level. As a part of that commitment, AAPT has authorized the creation of a set of Guidelines for Two-Year Physics Programs to help TYC educators and administrators assure that their physics courses and programs are based on acknowledged best practices in physics education.

The original Guidelines were developed by a task force established by AAPT and were published in 1990 after a preliminary draft was circulated widely within the physics-teaching profession. At the request of the Committee on Physics in Two-Year Colleges (CPTYC), a team of editors was established to revise the Guidelines in 2000. The team solicited the input of the two-year college physics community electronically before beginning the revision and publicized the proposed revisions through sessions at national AAPT meetings and a newsletter mailed to two-year colleges nationwide. The revised Guidelines were approved by the CPTYC and the AAPT Executive Board and published in 2002. AAPT adopted these Guidelines to serve as official standards by which interested faculty and administrators may evaluate and establish quality physics instruction in two-year colleges.

By 2020 advances in cognitive science related to science education, the abundance of findings from Physics Education Research (PER), and the advance of technology made the Guidelines outdated. In 2022, the recently established Organization for Physics at Two-Year Colleges (OPTYCs), funded by the National Science Foundation (NSF) under the auspices of AAPT, took the revision of the Guidelines as one of its major programs. A diverse team of TYC physics educators from around the country was established to undertake this task, under the direction of OPTYCs and AAPT leadership. The team included members from different types of two-year institutions who had a variety of areas of expertise. An important goal of the team was to ensure that the revised Guidelines were solidly supported by physics education research literature.

The draft revision was first reviewed by a team of physics educators and then reviewed by a team from the broader TYC physics education community. The final revision was approved by AAPT's Community on Physics in Two-Year Colleges and the AAPT Board of Directors and was published in 2026.

I. Use of the Guidelines

The quality of a TYC physics program is determined by many factors, including the quality of preparation and overall workloads of its faculty, as well as the adequacies of departmental budgets, facilities, and support services. The following Guidelines have been prepared to serve as:

- a guide to assist TYC presidents, deans and physics professors in developing standards to assure quality physics instruction in TYC physics departments;
- a guide for institutional self-studies and reviews; and
- a resource for regional accrediting groups when revising self-study guidelines and conducting visitations for assessment of programs.

The recommendations in these Guidelines are supported by research-backed documentation, and by cross-referencing documents from other related professional organizations such as the American Chemical Society Guidelines for Chemistry in Two-Year College Programs[1] and the National Association of Biology Teachers' NABT Guidelines for the Evaluation of Two-Year Undergraduate Biology.[2] All references used in the production of these Guidelines can be found in Appendix B. While every effort has been made to provide references to current and relevant research available at the time of the development of these Guidelines, faculty and departments should be cognizant of the fact that the field of Physics Education Research (PER) is continually adding to our body of knowledge regarding excellence in physics education. It is recommended that those overseeing program reviews, as well as faculty seeking to maintain excellence both inside and outside the classroom, remain current regarding the literature on physics education.

The Guidelines are intended to help TYCs provide physics students with the best possible education in the fundamental areas of physics, including its relation to other disciplines and society, and should be used to improve programs, not approve or disapprove them. There is great diversity in TYC institutions, programs, students, and curricula. The Guidelines attempt to take that diversity into account by providing general recommendations and standards for a comprehensive TYC physics program.

A. Goals of the Guidelines

The Guidelines seek to provide guidance to TYC physics programs in establishing programs that

- maximize the learning of physics in the classroom.
- meet the needs of a diverse student population.
- improve the appreciation of physics by students and within the surrounding communities.
- utilize and enhance the strengths of the institution and community.
- support the growing numbers of dual-enrollment students in TYCs.
- are comparable to programs of recognized quality.
- articulate with the four-year institutions to which most students transfer.
- meet local industries' needs for technical personnel.
- are consistent with the mission of the institution.

B. Program Assessment

Periodic review of physics programs is a critical component of effective departments. A transparent review process that includes the viewpoints of all stakeholders (administration, faculty, staff, students, and local communities) enables departments to highlight strengths, address shortcomings, and develop strategic plans for continual improvement. There are multiple resources available to assist in the development of periodic reviews[3,4] and strategic plans[5]. While many are written with four-year institutions in mind, they include recommendations appropriate to TYC physics programs, and for those TYCs that have no formal physics program, but which provide physics courses for transfer or career programs. These Guidelines provide a framework around which a TYC physics program review can be structured.

Whether a review is in response to an ongoing accreditation process or for internal use, a thorough review should:[6]

- Clarify the educational mission of the institution and how the college functions within the state's higher education system.
- State the role that physics plays within the educational mission of the college.
- Describe the administrative structure of the college and how the physics faculty function within this structure.
- Outline the decision-making process used within the division/department.
- Outline the ways in which the budget works to meet the needs of the program.
- Describe the ways in which faculty are supported, including
  - opportunities for appropriate professional development,
  - the availability of sabbatical,
  - support for travel to professional meetings, and
  - the ways in which scholarship is encouraged and supported.
- Describe the ways in which physics works with other departments within the college to provide specialized courses such as technical physics.
- Detail the articulation programs with science and engineering departments of four-year institutions.
- Describe the ways in which the division/department strives to meet the educational needs of the surrounding communities, including through outreach to local schools, businesses, and industries.
- Provide data illustrating the demographics of the student population served, as well as an assessment of the educational goals of those students (transfer intent, terminal degree, etc.).
- Describe the ways in which the division/department strives to meet the needs of a diverse student population.

C. Consideration of the Needs of Students During Program Assessment

The number and types of students taking physics at each two-year college campus vary greatly, and the department that includes physics should, as it embarks upon an assessment of its program, make use of its institutional database to determine the profile of the students it serves. Common reasons that TYC students take physics courses include:

- to prepare for transfer to a four-year college or university.
- to fulfill a general education requirement;
- to acquire skills needed for a new or current occupation;
- to fulfill a personal interest; and/or
- to improve basic scientific reasoning skills.

When planning for a program assessment, the inclusion of statistics regarding what students do after completion of their physics course(s) or after graduation would assist in formulating a clear picture of the physics student population and success of the program. The assessment should comment upon how courses are designed, scheduled, and conducted to meet the needs of the diverse student population. Other considerations when determining the extent to which a program meets the needs of students include:

- the means used to identify and address students' readiness for physics courses;
- the instructional format used to identify and address students' preconceptions;
- the ways in which faculty are utilizing innovative, research-based teaching methods to support student learning;
- how various assessments are utilized to monitor student learning;
- the ways in which computers and other technologies are integrated into instruction to support the learning process; and
- the availability of Honors courses and independent study opportunities.

In the end, the goal of a program assessment is to improve the program and better serve the students. Comparing an institution's program to these guidelines can provide a framework for programmatic assessment.

II. Curriculum

Because of the service role of TYC physics departments, there is a wide variety of physics courses offered at TYCs. TYCs offer several levels of transfer courses.[1]

- University Physics and other calculus-based courses typically serve students pursuing careers in the physical sciences and engineering.
- College Physics and other algebra/trigonometry-based courses for students pursuing careers in life science, medicine and other professional programs.
- Conceptual Physics and other courses for non-science majors, which are typically non-mathematical or include only minimal mathematics. Students taking these courses are often majoring in business, education and the liberal arts. These courses might be interdisciplinary, such as a physical science course that includes physics, chemistry, geology and/or other topics.
- Introductory Astronomy is often included as an alternative transferable physical science course for non-majors. These courses are generally designed to be conceptual or to include only minimal mathematics.

In addition, specialized courses may be offered. These courses are designed to serve specific program needs.[2]

- Physics or physical science courses specifically designed for students preparing to be K-12 teachers are increasingly being offered. These courses often include both scientific knowledge and pedagogy.[3]
- Physics for life sciences courses are also becoming more prevalent. These courses are designed to serve students preparing for health professions. The courses might be algebra/trigonometry-based, or in certain cases require calculus. Both the course content and laboratory experiences are designed to focus on applications of physics in for the life sciences.[4]
- Courses designed to serve specific vocational and technical programs are typically descriptive, with only limited use of mathematics, and include a limited range of topics dictated by the needs of the specific vocational program. Examples include physical science courses to serve firefighter programs, HVAC technician training, auto mechanics education, medical technologies, or specialized manufacturing technician programs.

When planning and assessing courses that enable students to meet their various academic and career goals, departments should consider designing courses to meet the needs of various student groups. Students taking a physics course for a vocational or technical program need a distinctly different course than students preparing for a career in physical science or engineering. Similarly, students preparing for a career in health professions should have a different course than the pre-engineering students. Course offerings should be consistent with the needs of the students and programs requiring physics. Regardless of the intended student population of a course, curricular standards associated with quality instruction must be adhered to.

A. Courses

a. Multiple modalities of instruction are possible, including
   i. traditional face-to-face (F2F)
   ii. studio, in which lecture and lab are integrated, and class time is spent primarily in activities such as experimentation and group work.
   iii. hybrid
   iv. online synchronous or asynchronous (see also Section B: Online Courses)

b. Standards
   i. Regardless of the modality or length of courses, content should be consistent across sections. If course length is reduced, course content and standards for the course must be maintained to ensure transferability and applicability to future course work. Course lengths should not be reduced at the expense of quality of instruction or content.[5] Specific examples on how to balance course length, quality, and content include explicit consideration of learning goals, flipping the classroom, and redesign of classroom activities, among others.[6-8]
   ii. All students should meet minimum pre- and co-requisites for the courses they are enrolled in. [9-11]
   iii. Combined courses, in which students subject to different requirements and/or enrolled in different courses are in the same classroom at the same time, should be avoided so that each group of students can have a course designed to meet their educational needs.

c. Course Design Considerations[2,12]
   i. Instruction should be based on the use of research-based instructional best practices.[13-18]
   ii. Instruction should include active learning strategies.[18,19]
   iii. Emerging technologies should be integrated into course content as appropriate.[20,21]
   iv. Instruction should include strategies to foster scientific reasoning.[22-25]
   v. Instructional strategies should be designed to address known student preconceptions of physical concepts.[26]
   vi. Courses should include computational modeling as a means of enhancing physics understanding and increasing real-world problem-solving ability. This is particularly important for calculus-based and algebra/trigonometry-based courses but can also be relevant for other courses.[27-30]
   vii. Courses should include strategies to foster success for all students, especially those from underrepresented groups, and course objectives/competencies should be designed to promote equity.[31-33]
   viii. The mathematical and conceptual level of any physics course should be consistent with the math prerequisites and conceptual abilities of the students who typically enroll in the course.[9-11]
   ix. Consider the time students need to spend outside of class to be successful when planning course requirements and scheduling length of courses.[34]

x. Course objectives/competencies should be clearly articulated, and the syllabus should accurately reflect those objectives.[35]
xi. Faculty who teach interdisciplinary courses should meet with faculty from included disciples to ensure that the expectations for the course are aligned with the expectations of all disciplines covered.[36,37]

d. Articulation and Transfer[38]
   i. Courses should align with articulation and transfer agreements with transfer partners.
   ii. There should be a formalized process in place for regular review of articulation agreements.
   iii. Be aware of existing program pathways and assure that courses meet requirements of the pathways.
   iv. Discuss expectations of student success in physics courses with other departments (other sciences, engineering, applied sciences, mathematics).

B. Online Courses[39-43]

a. Standards
   i. Course requirements should be the same for all students taking the course regardless of modality.
   ii. Faculty should design the course to focus on student engagement.
   iii. Technical skills and minimum technology requirements need to be clearly stated in course descriptions, so students clearly understand what is required.

b. Training
   i. Faculty teaching online courses should have online pedagogy and technology professional development prior to developing or teaching an online course.
   ii. Faculty should have access to opportunities to continually update knowledge and skills related to online teaching and learning.

c. Faculty workload
   i. Course loading for online courses should be equivalent to those for face-to-face courses.[44]
   ii. Compensation for online courses should be equivalent to that for face-to-face courses.
   iii. Since teaching online courses is more time-consuming for novice online faculty, professional development should include strategies for managing workload.[45]

d. Technical support is crucial; college personnel with computer expertise paired with knowledge of the institution's learning management system should be readily available to faculty and students.[46]

C. Instructional Materials[47,48]

a. Textbook decisions should reflect the objectives of the course and be of an appropriate level.

b. High quality instructor-developed course packs are appropriate if they meet the objectives of the course, are of an appropriate level, and they reduce costs to students.

c. Use of OER (Open Education Resources) is recommended to reduce costs to students and increase access but should not be used if the quality and/or level does not meet course objectives/competencies.

d. Students can be supported via the equitable practice of making textbooks and other materials available in libraries, study centers, etc.[49]

D. Technologies and technology access[2]

a. Integrate the use of computational skills (i.e. spreadsheets, programming languages, Arduinos, etc.) to enhance physics understanding and real-world problem-solving ability.

b. Integrate the use of simulations and other digital tools to help enhance physics understanding.[50,51]

c. Evaluate current and future trends in industry to implement into course work as appropriate.

d. Look closely at emerging technologies, taking into consideration the impact they have in the classroom and in future skills/careers for students. Structure the course to have the flexibility to adapt to emerging technologies which could enhance students' skill sets and better support understanding of physics.

e. Look particularly carefully at the use of AI by both faculty and students. The AI landscape is changing rapidly, even as its use is increasing. Decisions regarding the use of AI should be thoughtful and intentional.[52-54]

f. Both instructors and students should have technical support for the technologies used in the classroom and the laboratory.

E. Assessment/Evaluation[55-57]

a. Objectives and Outcomes
    i. The syllabus for the course should clearly outline all requirements for the course.[58-60]
    ii. The objectives and outcomes of a course should be clearly articulated, measurable, and student-centered.[61]
    iii. Outcomes should include the development of quantitative and qualitative reasoning skills, conceptual understanding, and problem-solving abilities.[25,61-64]
    iv. Evaluation practices should be fair and equitable.[65]

b. Assessment of instruction[2,11,66,67]
   i. Assessment of programs and instruction is critical to help improve teaching strategies and increase student access. A formal process should be in place for such assessments, which might include a combination of student evaluations, peer review, faculty self-study, and/or classroom observations.
   ii. Continual review and assessment of curriculum is preferable over periodic reviews.
   iii. The use of research-based assessment instruments is encouraged.[55]

III. Laboratories

Physics is an experimental science. Therefore, laboratory experiences should be an integral part of the physics curriculum. Excluding experiential learning from the physics curriculum is analogous to the elimination of physical training from the physical education curriculum or the de-emphasis of practice on a musical instrument in a music program. Students have more difficulty understanding the relationship between physical theory and experimental evidence without the personal experience of designing and conducting experiments. Well-designed, open-ended experiments expose students to the experimental basis of physics and combine many different skills and concepts.

Many institutions have switched to an integrated lecture-lab format or studio-style instruction, where there is no distinction between lecture and lab times. This format has been found to be successful in supporting and improving student learning.[1-4] Additionally, instructors should use at least a similar amount of time on laboratory-based instruction in the studio class as in a traditional lecture-lab format. When this type of approach is taken, the guidelines for laboratories listed below still apply. Institutions who are undertaking a transition to a more student-centered, active format should be intentional in applying established best practices to the transition process.[5]

Many of the recommendations listed below are framed according to AAPT's *Recommendations for the Undergraduate Physics Laboratory Curriculum.*[6] Although the interrelated recommendations from that document are sound and still relevant, much research has been carried out since its publication. The guidelines included here reflect some of that more recent work.

A. Laboratory Instruction

Laboratory instruction should be centered on constructing knowledge, modeling, designing experiments, developing technical and practical skills, analyzing and visualizing data, and communicating physics.[7,8] Laboratory activities should provide experiences that are central to and support the process of doing physics and are carried out using research-based teaching practices and inclusive pedagogy.[8,9]

a. Constructing knowledge, modeling, and designing experiments: Students should be given the opportunity to construct knowledge from personal experiences in the lab.
    i. Students should be given the opportunity to ask questions and develop hypotheses about observable phenomena, and to devise experiments to answer their questions and test their hypothesis.[10]
    ii. Students should be given the opportunity to develop models to represent physical systems, and then to use those models to make predictions and interpret the results of their experiments.[11-13]
    iii. Students should be given the opportunity to determine methods for reducing uncertainty in their experiments and to analyze data to determine the validity of the models they have developed.[14]

b. Developing technical and practical skills: Students should gain skill in using standard equipment, understanding the limitations of that equipment, and in using those tools in the design and completion of an experiment.[15-17]
    i. Students should be given the opportunity to gain hands-on skills in using standard analog and digital devices, and to understand the limitations and uncertainties associated with those devices.
    ii. Students should be given the opportunity to choose appropriate instruments when designing an experiment.
    iii. Students should be given the opportunity to use up-to-date tools such as video to record and analyze systems.

c. Analyzing and visualizing data: Students should gain experience in gathering, interpreting, and reporting data, at a level appropriate to their program of study.[18-21]
    i. Students should be instructed in how to select and produce appropriate plots to graphically represent their data and to extract information from those plots.
    ii. Students should be given the opportunity to use standard computer-based tools such as spreadsheets and statistical analysis software.
    iii. Students should be instructed in the analysis of experimental uncertainties as appropriate to the course objectives.

d. Students should gain experience in using computational modeling as a means of enhancing physics understanding and increasing real-world problem-solving ability. (See also Section III: Curriculum.)[22-24]

e. Communicating physics: Students should be instructed in how to present the results of their experiments in a way that demonstrates reasoned arguments supported by the results of their experiments, following standards of ethical scientific communication.[25,26]
    i. Students should be explicitly asked to describe experimental observations clearly and accurately, and to identify the most important physics concepts in the experiment, in both oral and written formats.
    ii. Students should be required to conduct experiments, carry out analysis and report their results in a professional and ethical manner.
    iii. Students should be provided with opportunities to plan and carry out experiments, discuss results, and interpret findings in small group settings that mirror the scientific process.

B. Online Laboratory Experiences

Many faculty hold the view that laboratory experiences are best done in face-to-face environments. However, the increase in the number of students taking advantage of online courses since the COVID years has led to many institutions making online courses a permanent part of their programming. This has led to the development of resources to support online laboratory experiences. Recent research has shown that well-designed online labs can provide comparable learning experiences to face-to-face labs.[27-29]

a. As indicated in part A, laboratory instruction should be centered on constructing knowledge, modeling, designing experiments, developing technical and practical skills, analyzing and visualizing data, and communicating physics. These principles should be applied to online labs as well.[30,31]

b. Because students in online courses lack significant opportunities for building communities of practice, a shared virtual space should be included in which students can interact with each other and the instructor.[32]

c. Faculty teaching laboratory experiences online should reference best practices and expert recommendations before converting or selecting online activities for their courses.[33]

C. Personnel

a. Laboratory sessions should be taught by qualified physics faculty.[34,35]

b. For faculty, one hour of time in laboratory supervision should be equivalent to one hour of time in lecture.[36]

c. There should be sufficient, full-time laboratory support staff so that instructors can focus on academic and scholarly activities.[37,38]
    i. It is recommended that there be one full-time laboratory coordinator for every 4 full-time-equivalent faculty.
    ii. Ideally, the laboratory coordinator should have a minimum of a bachelor's degree in physics or related field.
    iii. Laboratory coordinator responsibilities should include the maintenance of inventories and equipment, compliance with safety policies, and supervision of part-time and/or student lab assistants.
    iv. Provide laboratory support staff regular opportunities for professional development, and to discuss laboratory activities and/or policies with instructional staff.[6,8]
    v. Part-time and/or student assistants should be well-trained and experienced in the labs they will work in.

d. It is recognized that in smaller schools the hiring of full-time laboratory staff is not feasible. While the ideal situation is to have at least part-time laboratory staff available, if faculty are responsible for their own laboratory prep, accommodations must be in place to support those faculty.
    i. Lab prep time done by faculty should be counted as part of their required on-campus hours and/or load.
    ii. Faculty who must do their own lab set-up/take down should not be expected to take overload hours.[37]
    iii. Funds should be made available to hire student assistants for the purpose of lab set-up/take-down, and the time faculty spend training those assistants be applied to required service hours.

D. Assessment[39]

a. Explicitly determine the goals of laboratory instruction and align assessment to those goals.

b. Include both formative and summative assessment.

c. Use multiple measures to assess course-level student learning outcomes and utilize alternative methods of assessment where appropriate.[40,41]

d. Utilize rubrics as appropriate.

e. Utilize research-based assessment instruments whenever possible.[42,43]

E. Laboratory environment [8,9,36,44]

a. All full- and part-time faculty and staff should undergo laboratory safety training.

b. Safety should be emphasized as part of the instructional experience.

c. Laboratory classes should be limited to no more than 24 students per instructor, so that students' activities can be adequately monitored.[37,38,45,46]

d. Laboratories should have adequate supplies and equipment to support students' learning

e. Laboratory settings should have adequate and safe storage for all equipment and supplies.

f. Laboratory spaces should be maintained so that they are accessible to all learners.[47]

g. In cases of new or renovated laboratory spaces, institutions should prioritize design for collaborative learning. Ideally, faculty should have direct involvement in the design of these learning spaces.

IV: Student Support

Student support ranges from opportunities for underprepared students to gain the confidence and experience necessary to succeed in their physics courses to experiences that encourage all students to strive for higher levels of achievement. Support can also include initiatives beyond academic initiatives. For example, research has shown that the physical environment, including temperature, lighting, acoustics and décor, can impact student achievement.[1] A large body of research, some of which is cited in the recommendations of this section, has shown that students are more successful and more likely to persist in courses when they feel that they are part of, and welcome in, the learning community. In considering ways in which students can be best supported, faculty and departments should consider that the purpose of providing student support services is to ensure that all students have ample opportunity to succeed in their physics courses.

A. Tutoring Services

Free tutoring services should be provided for students.

a. Tutoring should be as widely available as possible. Offering sessions multiple times throughout the week and at varied hours, and in both in-person and appropriate online modalities, helps accommodate students' varied schedules. This is particularly important at TYCs, where many students have outside jobs and/or family responsibilities.[2-4]

b. Tutors should be aware of the techniques, strategies and goals of the courses they are tutoring. Since research has shown that tutors and teaching assistants do not always notice the cues to student difficulties or interpret their understandings correctly,[5,6] tutors should be trained in effective tutoring strategies. Ideally, tutors should have taken the course they are tutoring and come with instructor recommendations based not only on their content knowledge but also on their peer interactions.

c. Consider the use of Learning Assistants, an initiative that has been found to increase student gains in introductory physics, as well as supporting the development of physics identity for the assistants.[7,8] Alternately, include embedded tutors who sit in on the courses they tutor so they are aware of what and how content is being taught.[9,10]

d. Consider group tutoring sessions with tutors experienced in effectively facilitating group sessions.[11,12]

e. Consider the use of peer or near-peer tutors. Research has shown that peer interactions can have a strong impact on student success.[13-17]

B. Multimedia Summaries

When appropriate to course structure, consider the use of multimedia summaries and/or problem-solving videos for students to utilize outside of class.[18] Multimedia components, whether used in class or made available for student use outside of class, should be accessible to all students, including those with diverse needs.[19]

C. Departmental Culture Supports Science Identity

Create a departmental culture that is welcoming and encourages students to develop a physics/scientific identity:[3,4,19-25]

a. Provide comfortable study spaces for students to gather.

b. Encourage, and provide the means and space for, students to create peer groups for study and social connections.[26] Some students might find digital spaces as an effective means of peer support.[27]

c. Create a culture that encourages faculty to support all students, including those who may have limited previous physics or math experiences (i.e. no prior high school physics).[28,29]

d. Encourage faculty to express the value of various career paths related to physics (engineering, teaching, computing, industry), so that students feel a part of the physics community even if they are not majoring in physics.

e. Encourage faculty to include examples of the relevance of physics to everyday life and to careers outside of STEM, so that all students see the value of physics in their lives.

D. Departmental Culture Supports Underrepresented Groups

Create a department culture that is accepting and welcoming to underrepresented groups.[30-36] In 1947, the Congressional report Higher Education for American Democracy[37] stated that "…various barriers to educational opportunity involve grave consequences both for the individual and for society" (p.35) and that "the time has come to make public education at all levels equally accessible to all, without regard to race, creed, sex, or national origin" (p.38) This core foundational document not only coined the term "community college" but also established the support of underrepresented groups as one of the critical goals of TYCs. (See Appendix A for additional information.) The department culture should support those ideals.

a. Consider changes in course structure and curriculum that maintain high standards while reducing equity gaps.[30-32]

b. Establish codes of conduct for faculty and students that maintain an encouraging and positive learning environment for women and underrepresented groups in physics.[33]

c. Establish mentoring programs for women and underrepresented groups in physics.

d. Recognize that students have multiple, intersecting identities, which may uniquely affect their educational experiences within the physics program. Initiate programs which provide individualized support for students.

e. Recognize that different groups have different needs and concerns, and avoid making assumptions about individuals' needs, interests, or competencies based on their identities, whether self-report or perceived.[37,39]

f. Recognize the unique barriers experienced by students with disabilities, and provide accessible classroom, laboratory and study spaces that support all learners by using Universal Design for Learning (UDL) Guidelines to proactively design physical spaces and courses.[40-44]

g. Recognize the needs of first-generation college students and provide mentors and intentional support for those students.[45]

E: Institution-Wide Support

While not directly the responsibility of the department where physics courses are located, institution-wide student support is critical. Two-year college students are more likely to be first-generation college students, older, have full-time jobs, have dependents, or have food and/or housing insecurity than students at four-year institutions.[2,46,47] While it is not the responsibility of the department to maintain those services, the department must assure that faculty and students are provided with information about those non-academic resources and how to access them.[48]

a. Assure that all faculty know about non-academic support services such as food pantries, emergency financial support, counseling centers, safety escorts, support groups and other resources.

b. Maintain an up-to-date list of on- and off-campus resources to share with faculty, and ensure that all students are provided with that information.

c. Establish training for faculty to recognize indicators of mental health crises, food insecurity and other issues and establish policies for confidential referral to student resources for students who can benefit from them.

V. Personnel

The importance of qualified and dedicated faculty and other personnel to the achievement of student success cannot be overstated.[1] It is critical that the academic integrity of a department not be jeopardized by the hiring of unqualified personnel, nor by human resources or management practices that do not support personnel in creating teaching environments that foster student success. Likewise, departmental policies should support faculty in their efforts to innovate and develop instructional strategies that foster student success.[2] These supportive policies should apply to all faculty, including contingent faculty, which in this section, refers to personnel who are on contracts or otherwise employed without long-term stability.

A. Hiring Practices

Hiring practices should be focused on finding strong, qualified and diverse faculty.[3]

a. Faculty should have a minimum of a Master's degree, including at least 18 credit hours in discipline.[4,5] This requirement should not be waived for faculty teaching online courses. Additional qualifications as required by the institution's accreditation agency should be met.[6]

b. Faculty who will be expected to teach online courses should have demonstrated competency in online pedagogy. (See Section II: Curriculum, Part B)

c. Contingent faculty should have the same minimum qualifications as full-time faculty.

d. Departmental faculty should represent a diversity of experiences, expertise, and specialization, so that students have an opportunity to experience the breadth of the field.[3,5,7]

e. Hiring pools should be demographically diverse, with the goal of a diverse faculty group to serve as role models for all students, regardless of gender, ethnicity, race and disability status.[7-13]

B. Contact Hours

Contact hours, defined as the time spent in direct supervision of students either in classroom, lab or online, should not exceed amounts consistent with the ability to provide excellence in instruction.[3-5]

a. Teaching loads should not exceed 15 hours per week.

b. Instructional hours for online courses should be equivalent to classroom instructional hours.[14]

c. Laboratory instructional contact hours should be equivalent to classroom instructional contact hours.

d. Adequate time should be provided for course development, assessing and improving curriculum, service activities (to the department, the institution and the community), and office hours.

e. The additional workload required to develop and teach online courses should be considered when planning for overall workload and service activities.[14-16] (See also Section II: Curriculum, part B.)

C. College Service[3,17]

a. Assure that college service-related activities such as committee work are assigned equitably.

b. Assure clarity in the expectations for service hours based on experience, appointment types, and career stage, and that institutional needs are balanced with faculty needs.

c. Assure that faculty are given credit for the service activities they undertake.

d. Be aware that women and faculty of color are often subject to a "minority tax" in service, mentoring, and diversity-related work.[3,17,18] Ensure that proper recognition and compensation is given for this work. In addition to acting as uncompensated labor, the minority tax often co-exists as an opportunity cost. Ensure that affected faculty are offered the same opportunities for positions, growth and/or responsibilities as all faculty, and that they are given the agency to shape their own careers by accepting or declining those opportunities.

D. Full-time and Contingent Faculty

The fraction of courses taught by contingent faculty should not exceed 25%. Some research has suggested that as their exposure to contingent faculty increases, students' achievement is negatively affected, and they are less likely to re-enroll, graduate, or transfer to a four-year institution.[19-22] Successful programs for professional development can help adjuncts feel as if they are valued members of the institution and help increase student success rates.[22-26]

E. Support for Contingent Faculty

Contingent faculty should be provided with mentoring and pedagogical support, and intentional efforts should be made to help them feel they are important members of the department.[23-26]

a. Provide contingent faculty with a formal orientation process and a mentor or faculty liaison.

b. Provide meaningful observation and assessment of teaching practices and student feedback on a regular schedule.

c. Provide contingent faculty with meaningful means of making their needs known to the department/institution, such as through a formal feedback process.

d. Integrate contingent faculty into the culture of the department through efforts such as providing office space, invitations to department meetings, and providing minutes of meetings to those faculty unable to attend. However, it should be clearly stated that attending meetings and other unpaid activities are not expected, and that they will play no role in future hiring or scheduling decisions.

e. Contingent faculty should have access to funding for relevant professional development.

F. Professional Development

All faculty, including contingent faculty, should be given adequate time and funding to participate in discipline-specific and pedagogical professional development.[3-5,24-30]

a. Faculty are professionals, and as such they should be encouraged to be members of professional societies and be provided with funding to do so.[31]

b. In-house professional development should be planned in conjunction with faculty to ensure that it is relevant.[27-29]

c. Sustained, ongoing professional development activities have been demonstrated to have the greatest impact on student outcomes. Funding should be provided to enable faculty to engage in sustained collaboration, mentoring, coaching, institutes, workshops and seminars.[27-30]

d. Opportunities for travel to discipline-specific professional meetings or other workshops are critically important for student success.[31]

e. The scholarship of teaching and learning, including instituting, evaluating and reporting on curricular and/or pedagogical change, should be valued and supported.

f. Faculty should be supported in their efforts to reform curriculum and implement innovation to support students and improve outcomes.[2,32-36]

g. Teaching schedules and other responsibilities should be structured in such a way that increases opportunities for faculty to engage in relevant professional development activities.

G. Leadership Development

Planning for sustaining faculty leadership should be intentional.[1,3,8]

a. Administration should support activities that develop new leadership so that successful initiatives and programs do not die with the loss or retirement of a key faculty member.

b. Positive interactions with colleagues, administrators and students are key to successful programs. As such, the maintenance of avenues of respectful communication and a constructive working relationship between and among faculty and administration should be a primary goal.

H. Support Personnel

Adequate support personnel who are dedicated to educational excellence should be available, so that faculty can focus on instruction and student success.[37-39] (See also Section III: Laboratories)

a. Laboratory support, in the form of laboratory managers and/or trained student laboratory technicians, should be provided.

b. Specialized computer technical support should be available.

c. Tutors should be readily available for students, and those tutors should be familiar both with the content of the different courses taught by the department and the pedagogical techniques used by the faculty in those courses.[40] (See also Section IV: Student Support)

d. Support personnel should have access to relevant professional development activities and funding to do so.[41,42]

VI. Facilities

It is important to design facilities that support physics programs thoughtfully, not only for safety, but also for providing welcoming environments that support student success. As previously noted, research has shown that the physical environment, including lighting, acoustics and décor, can have significant impact on student achievement.[1,2] Departments and faculty should recognize the unique barriers faced by students with a wide variety of disabilities, and be proactive in the planning of accessible spaces in which all students can feel comfortable and welcome. Faculty are also affected by the environment in which they teach, hold office hours, and interact with other faculty. The teaching spaces can also have a large impact on which pedagogical innovations faculty can employ. All decisions regarding the physical spaces in which physics faculty and students teach, learn and interact with each other should be focused on the goal of ensuring that all students have the opportunities for success.[1-4] As with the design of laboratory spaces, the renovation or creation of instructional spaces should include the direct input of faculty. Institutions should reference the Americans with Disabilities Act Standards for Accessible Design[5] and relevant state compliance standards when planning instructional, laboratory, and office spaces.

A. Instructional Spaces

a. Classroom spaces should be designed to take advantage of natural light whenever possible, with good acoustics and temperature control,[2] with the ability to be fully darkened as needed for experiments or demonstrations.

b. All classroom and laboratory spaces should be accessible so that all students, including those with disabilities, can fully participate in the learning environment.[2-4,6,7]

c. Classroom furniture should be adaptable to a diversity of activities such as seminars, lectures, and large and small group work. The goal is to increase opportunities for interaction, collaboration and engagement.[8,9]

d. Classroom design should include adequate space and walkways between tables. Active learning design has been shown to increase between-student interactions, as well as between faculty and students. While active learning can be done in a lecture hall or a classroom with rows of desks, spaces designed specifically for active learning can make instruction more effective and efficient.[9]

e. Classrooms and laboratory spaces should include full audio-visual capabilities and computers for student work. The use of appropriate technologies has been shown to be an important factor for successful physics instruction.[3]

f. The objects and displays such as posters or other images should project a welcoming, inclusive environment for all students.[2]

g. Since expense and/or safety of some equipment may prohibit use by students, classroom and laboratory spaces should have the capacity for demonstrations by the instructor so that all students can clearly see and interact as appropriate with the demonstration. There is some evidence that students learn more from well-designed video demonstrations, so consider supplementing with quality online versions of demonstrations carried out in class, especially in situations where space considerations may restrict some students from seeing the demonstration clearly.[10]

h. Laboratory space and equipment must be adequate for all students, including those with disabilities, to have personal experience in designing and performing experiments.[4,6,7,11] Consider providing the same equipment and materials on a variety of shelf heights to enable better access, rather than grouping all of one item on a single shelf or cupboard.

i. Adequate equipment for each experiment should be available to enable groups of no more than four students, preferably two to three, to share an entire set of equipment. More than four students per experiment generally leads to some students becoming passive observers rather than engaged learners.[12] (See also Section III: Laboratories, Part E)

j. For safety and to assure pedagogically effective supervision of students, the lab instructor should not be expected to monitor more than 24 students in one lab session. If larger sections are necessary because of facility limitations, instructors should have adequately trained assistants such as teaching assistants who are familiar with both the experiments and the pedagogical strategies used in the laboratory setting.[13,14]

k. Virtual spaces for students, such as learning management systems, laboratory simulation platforms, laboratory sensor software, etc, should be given the same consideration as the physical learning spaces. (See Section II: Curriculum and Section III: Laboratories)

B. Work and storage spaces[13,14]

a. A secure equipment storage area is critical to meet safety and security requirements for expensive and/or easily breakable equipment and for potentially hazardous materials and/or equipment.
b. Workspace and appropriate tools should be provided for instructors or laboratory personnel to repair equipment and/or construct new demonstrations. This could be a dedicated space for the physics program, or a shared space with other laboratory-based programs such as biology and chemistry.

C. Office spaces[13,14]

a. All faculty should have conveniently located and well-equipped office space that includes a computer and whiteboard for student work. Ideally the office should be adjacent to or near classroom and laboratory spaces.

b. Office space should include enough room for comfortable seating for student consultations and assistance and be designed for accessibility for all students.

c. All faculty should have access to a printer, either in their office or in a convenient central location. A photocopier should be available in an easily accessed central location.

d. Ideally, all faculty should have access to a common room with a coffee pot, refrigerator and microwave oven.

D. Common areas[1,15]

a. Students should have access to a dedicated study room close to classrooms/labs with computer access, comfortable seating, reference books and, preferably, coffee pot, refrigerator and microwave oven. Dedicated student space signals to students that they are valuable members of the institution and that their needs are taken seriously.[3,4,11,16]

b. If possible, identify a quiet lactation space for students who are also nursing mothers.

c. Assure that common spaces, both formal and informal, support collaboration and interaction between faculty members, between students and faculty, and between students.

d. Identify spaces for student groups such as Society of Physics Students chapters, clubs and study groups to utilize.

e. Assure that all common spaces are inclusive and accessible.[17]

VII: Budget

While it is not possible to provide specific dollar amounts due to changing economic environments, the budgetary goal is to ensure that all students have access to excellent instruction and laboratory experiences. In addition, those experiences should utilize modern equipment and best practices in physics education.[1,2]

A. Classroom expenses[2,4]

a. Sufficient funding should be available to ensure that classrooms are equipped with current technologies, including up-to-date audiovisual equipment.[5]

b. Consideration should be made for expendables used in the instructional process. For example, if classroom time is dedicated to students doing whiteboard work, there will need to be sufficient funds for ongoing replacement of markers.

B. Laboratory expenses[2,5]

a. Sufficient funding should be available to ensure that laboratory spaces are equipped with current technologies, including computers, probeware, and video analysis capability.

b. Sufficient funds should be provided to make necessary repairs to equipment, or to replace equipment if repairs are not possible.

c. Sufficient funds should be provided for consumable laboratory supplies.

d. Regular updates to new technologies that support learning should be considered as capital investments to ensure that instruction remains relevant.

C. General expenses[2-6]

a. Sufficient funds should be available to support the time it takes faculty to review, adapt and update OER resources.[7] (See also Section II: Curriculum, part C)

b. Sufficient funds should be available to provide updates to both classroom and laboratory software as needed.[5]

c. Funding should be available for faculty to be members of professional societies and to participate in and lead relevant, discipline-based professional development .[6, 8-11]

d. Support personnel, such as laboratory managers, should also have access to funds for professional development.[12,13]

e. Sufficient funds should be available to meet the needs of faculty for office supplies, mailing, duplicating, printing and communications.

f. Funds should be made available to support the hiring of student assistants to assist in laboratory and demonstration set-up, provide peer-led assistance in laboratories and classrooms, and other activities as needed. Such experiences have been shown not only to benefit learners, but also to be beneficial for the student assistants' learning and professional development.[4,14,15]

g. Sufficient funds should be allocated to support local outreach if such activities are part of the college's mission. Outreach activities such as science fairs, science demonstration shows, night sky viewings, and school visits provide opportunities provide opportunities for students to engage with content outside of the classroom and to foster community support for the college and the department and.[16-19]

h. Sufficient funds should be available for occasional expenses such as program reviews, field trips, hosting professional meetings, etc.[20]

D. External Funding[3,9]

a. The institution should commit to fully funding excellence in the physics program, including facilities, equipment and instructional innovation.

b. Faculty who wish to pursue grants or other avenues of external funding should be supported in doing so, and such activities should be considered part of their load, not solely overload work.

c. Grants and other sources of external funding should not be used for the normal functioning of the program, but rather for special projects such as undergraduate research.

Appendix A: History and Mission of the Community College

For over 120 years, community colleges have played an important role in higher education in the United States. Today's community colleges provide open-door access to millions of students, providing access to a college education that might not otherwise be available and life-long learning for students of all ages. They also serve students who want the benefit of a lower-cost first two years of higher education, students who like the convenience of a local college, adults looking for certifications for job advancement or career changes, and technical or vocational degrees and certificates. There has also been an increase in the number of community colleges that award bachelor's degrees, most notably in Washington state and Florida.[1]

According to the U.S. Department of Education, in the 2020-2021 school year there were 1022 community colleges, representing 28.1% of the institutions of higher education that participated in one or more federal financial aid programs. Those institutions served 8,871,749 students, or 43.7% of all students enrolled in undergraduate education. Of those students, 72.2% were enrolled part-time. In 2020-2021, community colleges awarded 859,826 associate's degrees, 619,708 certificates, and 30,067 bachelor's degrees.[2]

Community colleges tend to be more representative of the racial, ethnic, and socio-economic populations of their communities than other higher education institutions.[3] For example, in the fall of 2023, 42% of students enrolled in public two-year colleges were Black or Hispanic, compared to 30% enrolled in public four-year institutions. Community colleges also provide greater access to higher education based on income, with 57% of students in public two-year colleges having family incomes below 200% of the federal poverty level, compared to 46% of students attending public four-year institutions.[4] As seen in Table 1, community colleges also serve large numbers of students who are older, have dependents, and/or are working while enrolled.

Race/Ethnicity		Life Situation	
Asian	6%	25+	29%
Black	12%	Dependent Children	23%
Hispanic/Latino	29%	Working (Full Time Enrollment)	44%
Native American	1%	Working (Part Time Enrollment)	80%
White	41%	Receive Pell Grant[2]	32%

Table 1: Characteristics of Community College Student Population[4]

Joliet Junior College in Joliet, Illinois is often cited as the nation's first public community college, but the history of the community college is clouded by many varying definitions and evolving goals. Early community colleges, then called junior colleges, were often established as offshoots of high schools. As early as the 1870s high schools were experimenting with college level classes, including Joliet's Central High School which had collegiate-level chemistry and Latin as early as 1884.[5]

Much of the reason for the integration of college-level courses into the high schools lies in the expanded access to higher education brought about by the first and second Morrill Acts. The

Morrill Act of 1862, also known as the Land Grant Act, helped expand access by donating federal land for the formation of colleges and universities focused on agriculture and engineering.[6] The Morrill Act of 1890 required that land grant universities must not consider race in admissions, or that states must establish and support separate universities for non-white students.[7] The effect of these acts was to create a growing number of students desiring access to universities, which led to many university administrators worrying about an influx of underprepared and/or unqualified students.

University presidents began to argue that the freshman and sophomore years should be separated from the real work of the university, which they felt was research. The common version of the creation of community colleges indicates that, in 1892, William Rainey Harper, president of the University of Chicago, acted on this belief. Harper divided the University of Chicago into a "junior college," consisting of freshmen and sophomores, and a "senior college." His goal was to restrict access to the upper levels to students who were "truly gifted," allowing universities to become more selective and focus on advance programs and graduate students.[8,9] In his quest to encourage high schools to take on the education of students in the first two years of college, he collaborated with J. Stanley Brown, principal of Central High School in Joliet, Illinois, to establish a formal junior college associated with the high school.

However, records indicate that Central High School had collegiate level courses as early as 1884, and in 1901, the year typically given for the formation of Joliet Junior College, there were 22 high school graduates enrolled in college courses at the school. It was not until 1913 that the first use of the phrase "junior college" was first seen in the minutes of faculty meetings at the school. The junior college did not formally separate from the high school until 1916, when it moved to its own building and the school board petitioned the North Central Association to accredit its junior college.[5] Clearly the development of junior colleges was not a matter of formation on a particular date, but rather an incremental evolution to the form it has today.

In 1907 California passed the Upward Extension Act, which was the first state law authorizing the formation of junior colleges and which laid the foundation for the formation of others across the country.[9] In 1921 California extended that legislation to allow the formation of independent junior colleges not associated with high schools. By 1910, nationwide there were 3 public junior colleges, growing to 14 by 1914.[5] A report on junior college published by the Bureau of Education in 1919 states that at that time there were over 100 institutions calling themselves junior colleges.[10] Growth accelerated after the passage of the California initiatives until by the early 1930s there were junior colleges in all but 5 states.[11]

Even with this expansive growth, university support for junior colleges was still based primarily on an elitist motive, with the goal of junior colleges to act as gatekeepers for admission to upper division programs.[5] In 1916, at the 53rd annual meeting of the National Education Association, Alexis Lange, Head of the Department of Education, University of California Berkeley, stated that

> "…the upward extension of the high school was from the first urged along… in the educational interest of the great mass of high-school graduates who cannot, will not, should not become university students. Such extensions, it was argued, might and should make it possible for the small minority to enter a university… The junior college will

> function adequately only if its first concern is with those who will go no farther, if it meets local needs efficiently, if it turns many away from the university into vocations for which training has not hitherto been afforded by our school system."[12]

The prevailing attitude of university leaders was that junior colleges should provide a two-tiered approach, with an emphasis on vocational programs, and courses for preparation for transfer to a university for the minority of students deemed "suitable" for upper-level work. Other influences such as populist drives to provide an avenue of upward mobility, economic stability, religious enthusiasm, and a desire for an institution to provide education for less qualified upper- and middle-class students all played a role in the junior college movement. In 1920 the American Association of Junior Colleges (AAJC) was formed, and its early leaders lobbied for the importance of vocational programs and the need for counselors to ensure that students would be taking courses "most appropriate for their abilities." AAJC's leaders called for two-thirds to three-quarters of students in junior colleges to be enrolled in terminal programs.[13]

The Depression years saw large increases in enrollments at junior colleges, increasing from 56K students in 1929 to 150K by 1938.[5] During this period the leadership of AAJC continued to push for increased emphasis on vocational programs, arguing that not everyone could be a member of the academic elite, and that vocational programs would reduce drop-out rates and ensure that all graduates gained marketable skills. Despite these efforts most institutions remained focused on academic programs that parallelled the first two years of a university program. Students, and their parents, viewed junior colleges as an affordable vehicle for social mobility, and considered vocational programs as educational dead-ends that would leave them with no options for higher education. As a result, vocational programs did not see major growth through the decades from the 1930s into 1960s, with no more than 25-30% of students enrolled in junior colleges being enrolled in vocational programs.[13]

As World War II was ending, the prospect of large numbers of veterans returning to college campuses was, in the words of President Truman, "taxing the resources and resourcefulness" of institutions of higher education. At the same time, university and junior college leaders were struggling to define the role of junior colleges in the educational landscape. In 1946, President Truman called for a Commission on Higher Education to address the concerns of higher education. Junior colleges received a boost in both status and visibility with the 1947 release of the Report of the President's Commission on Higher Education, *Higher Education for American Democracy*.[14] The report laid out in detail the barriers to higher education and the need for reforms to address them. Among the concerns raised by the report were regional, economic, racial, and religious barriers, as well as the concentration of higher education programs on "academic aptitude," while neglecting students with other talents (pp. 27-38). The report went on to dedicate an entire section to junior colleges, using the term "community colleges" to emphasize the commission's belief that these colleges should be focused on serving the needs of the communities in which they were located. The specific recommendations laid out by the report for community colleges were (pp. 67-70):

- Increase the number of community colleges.
- Increase the number of activities of the community colleges.
- Allow some community colleges to offer 4-year programs.

- Maintain the focus of the community college on serving the entire community, by seeking to become centers of learning for the entire community, with or without the restrictions that surround formal course work in traditional institutions of higher education.
- Act as a center for adult education.
- Emphasize programs of terminal education, both general education and vocational training.
- Include general education for personal and social development as part of training programs.

The report also stated that "There is no reason to believe that community colleges, if they are adequately staffed, cannot do as good a job as the lower divisions of 4-year colleges in preparing students for advanced work in liberal and professional education." (p. 70)

The early 1960s were the beginning of a period of dramatic changes in community colleges. First, the initial wave of post-WWII baby boomers was reaching college age, increasing the demand for access to higher education. This demand created a boom in the building of community colleges, with approximately half of the nation's community colleges being created in the 1960s.[15] During this period and beyond, enrollment in community colleges grew more than any other segment of higher education. From 1965-1999, enrollments at community colleges grew five-fold, while those at four-year institutions roughly doubled.[16]

Another impact was an initiative by the W.K. Kellogg foundation to provide grants for the training of community college leaders. These grants, which were directed to universities, added increased status to community colleges. Additional support for increased emphasis on vocational programs came through the support of businesses and their need for highly trained workers,[8] as well as from Congress through the passage of the Vocation Education Acts of the 1960s, which designated portions of the funding to go to community colleges.[3]

Finally, the launch of Sputnik in 1957 acted as a clarion call for science and technological education in the US. In response, Congress passed the National Defense Education Act in 1958, calling for increased emphasis on science and mathematics programs to encourage more students to enter scientific and technological careers. Science and mathematics education became the roadway that would assure that the US would win "the science and technological race with Soviet Russia."[17] While the act addressed education at all levels, community colleges responded along with K-12 and four-year schools in moving toward mathematics and science curricula that would help produce the scientists and technicians needed in the fast-evolving space age.

The Commission on College Physics (CCP) is one lasting-impact initiative that came out of this era. The CCP was formed in 1960, funded by a grant from the National Science Foundation (NSF) to address the improvement of physics education at the post-secondary level. The CCP initiated the Panel on Physics at TYCs (PP-TYC), setting as its priorities technical physics courses, the recruitment and preparation of TYC faculty, and the development of resource materials. When the CCP was phased out in 1970-71, AAPT was tasked with maintaining the CCP initiatives, including the TYC efforts. As a result, AAPT formed the Committee on Physics in Two-Year

Colleges (CPTYC) in 1970. The work of this committee, now the Community for Physics in Two-Year Colleges, continues within AAPT.[18,19] For further information regarding the work of the TYC physics community within AAPT, see Lui, O'Kuma and Hilborn (2021).[20]

By the late 1970s, most community colleges had become predominantly vocational institutions. Much of this change was driven by the notion that the new high-tech industries of the space age would increase job opportunities for students who had the appropriate training. The predominance of vocationally oriented programs continued into the 1980s, in part because community college leaders saw the opportunity for a market niche that would help them compete with four-year institutions.[8] In 1984 the American Association of Community and Junior Colleges released a policy statement asserting the primary importance of the terminal associate degree in the community college "…as central to the mission of the community, technical, and junior college." (p. 23)[9]

Despite the continuing focus on vocational programs and their importance to communities, transfer programs remain an important part of the community college mission. By the 2000-2001 academic year, about 41% of associate degrees awarded were in liberal, general studies and humanities, degrees typically earned by students desiring to transfer to a four-year institution.[16] Actual enrollment data show that of students enrolled in community colleges in the fall of 2015, only 33% transferred to four-year institutions, suggesting than many of the associates were terminal degrees for their recipients.[21] In contrast, certificate programs at community colleges have seen a growth rate of 28.3% since fall 2021, enrolling 752,000 students in the fall 2025 term.[22]

A more recent trend in community colleges has been the addition of bachelor's degrees. By 2020 there were 24 states with community colleges authorized to offer baccalaureate programs, with Washington State and Florida leading the way. These programs are typically occupationally focused applied science or technology degrees which build upon existing associate's degree programs, serve the local and regional workforces, and are not offered at local or feeder universities.[1,23,24] Data suggest that community college baccalaureate programs (CCBs) serve more students who are older, have full-time jobs and/or who have dependents than associate degree programs, and that they also enroll more underserved and/or economically disadvantaged students.[24] Students enrolled in CCBs are also more likely to reflect the ethnic and racial makeup of the local community. Concerns raised in relation to CCBs include the risk of community colleges moving away from their traditional open-access mission, competing enrollments in similar programs at local universities, expanding costs related to accreditation, the hiring of more faculty with doctoral degrees, and acceptability by employers. Overall, research has shown that community colleges continue to maintain their commitment to open access and to their associate's programs with minimal impact on four-year institution enrollments and that employers believe graduates possess the knowledge and skills needed in the workplace.[23,24] However, community colleges are altering their financial practices, through the hiring of more faculty with doctorates, the expansion of services for the baccalaureate programs, such as libraries, advisors and additional tutoring services, and conflicts over allocation of resources between programs. For some institutions, this has resulted in higher costs for students.[1]

Community colleges today, more than ever, are designed to serve the communities in which they are located. They provide transfer programs, adult and continuing education, dual enrollment, certificate programs and terminal two-year degrees, baccalaureate degrees, business and workforce development, as well as community outreach programs. Despite their growth and success, they still face many challenges. Some of these challenges include completion and transfer rates. While 80% of students entering community colleges state a goal of attaining a bachelor's degree or higher[25], only 33% of those students transfer to a four-year institution, and only 48% of those who transfer earn a bachelor's degree within six years, corresponding to an overall completion rate of 16%.[18] As seen in Table 2, the rates of completion are even lower when separating out for gender, age, income or race.

Group	Overall Completion Rate
Students declaring Bachelor's intent	16%
Male	14%
25 or older	9%
Low income	11%
Black	9%
Hispanic	13%

Table 2: Rates of bachelor's degree completion within six years for students attending community colleges[18]

When looking at the completion rates, we must acknowledge the unique challenges of the students that community colleges serve. As previously noted, students at community colleges tend to be older, have jobs, have dependents, and are attending part-time. These students have stressors in their lives that affect their ability to maintain enrollment. The reasons students provide for dropping out vary, but typically include work schedules, personal health, childcare, or inconvenient class scheduling. Of those who leave, 39% have never participated in a study group, 34% have never socialized with faculty or advisors, and 45% have never spoke to faculty outside of class.[3] Students who must work, care for family, or who have health concerns may be unable to participate in the types of interactions known to contribute to college success. Devising the means to provide support to those students remains one of the primary challenges facing today's community colleges.

Despite these challenges, community colleges remain a critical and vital part of the higher education system in the US, providing access to higher education and pathways to economic mobility for millions of citizens. The role of community colleges has been evolving since their creation, and it continues to evolve. Despite the wide range of programs and degrees, the mission of community colleges remains focused on open access to high-quality education for the communities in which they are located.

Appendix B: References

Section 1: Use of the Guidelines

1. American Chemical Society. (2025). *ACS Guidelines for Chemistry in Two-Year College Programs*. https://www.acs.org/education/policies/two-year-college/guidelines.html
2. National Association of Biology Teachers. (2019). NABT Guidelines for the Evaluation of Two-Year Undergraduate Biology. https://nabt.org/files/galleries/Guidelines_for_the_Evaluation_of_2Y_UG_Biology.pdf
3. American Physical Society and the American Association of Physics Teachers. (2025). How to Undertake an Undergraduate Program Review. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/how-to-undertake-an-undergraduate-program-review
4. American Association of Physics Teachers. (2005). *Guidelines for Self-Study and External Evaluation of Undergraduate Physics Programs*. https://www.aapt.org/Resources/upload/Guide_undergrad.pdf
5. American Physical Society and the American Association of Physics Teachers. (2025). How to Create and Use a Strategic Plan. *EP3: Effective Practices for Physics Programs.* https://ep3guide.org/guide/how-to-create-and-use-a-strategic-plan
6. American Physical Society and the American Association of Physics Teachers. (2025). Supplement: Topics a Department Might Explore in a Program Review. *EP3: Effective Practices for Physics Programs.* https://ep3guide.org/guide-overview/topics-a-department-might-explore

Section II: Curriculum

1. Chu, R.Y., White, S. and Oman, J. (2025). Physics Enrollments in Two-Year Colleges. American Institute of Physics. https://www.aip.org/statistics/physics-enrollments-in-two-year-colleges-2023
2. Monroe, M. B., O'Kuma, T.L. and Hein, W.; Norton, M.J. Ed. (2005). Chapter 5: Project Findings. *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* American Associate of Physics Teachers. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf
3. American Physical Society and the American Association of Physics Teachers. (2025). High School Physics Teacher Preparation. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/high-school-physics-teacher-preparation
4. American Physical Society and the American Association of Physics Teachers. (2025). Introductory Courses for Life Sciences Majors. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/introductory-courses-for-life-sciences-majors
5. Kidd, A.B. (2025). Higher Ed in Half the Time: A Literature Review on the Shortened Course Format. *Teacher and Learning Excellence through Scholarship*, Vol. 5 (1). https://tales.journals.publicknowledgeproject.org/index.php/tales/article/view/3494
6. Fladd, L., Iuzzini, J. and Lawton, J. (2024). *Preparing for Shortened Academic Terms: Guide, Workbook, and Spotlights.* Achieving the Dream. https://achievingthedream.org/preparing-for-shortened-academic-terms-guide-workbook-and-spotlights/
7. Fladd, L. (2026). *Preparing for Shortened Academic Terms: A Companion Guide.* Achieving the Dream. https://achievingthedream.org/wp-content/uploads/2026/03/SAT-Guide-2026-1.pdf
8. Center for Teaching and Learning. (2026). *How do you flip a classroom?* University of Texas at Austin. https://ctl.utexas.edu/how-to-flip

9. Mahon, R., Dumont, S., Morse,D., et al. (2010). *Student Success: The Case for Establishing Prerequisites through Content Review.* The Academic Senate for California Community Colleges. https://www.asccc.org/sites/default/files/publications/Prerequisite-review-fall2010_0.pdf
10. American Physical Society and the American Association of Physics Teachers. (2025). Introductory Courses for STEM Majors. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/intro-courses-for-stem-majors/
11. American Physical Society and the American Association of Physics Teachers. (2025). Courses for Non-STEM Majors. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/courses-for-non-stem-majors/
12. Monroe, M. B., O'Kuma, T.L. and Hein, W.; Norton, M.J. Ed. (2005). Chapter 3: Best Practices. *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* American Associate of Physics Teachers. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf
13. Bransford, Brown and Cocking, Eds. (2004). *How People Learn.* National Academy Press, Washington, DC. https://nap.nationalacademies.org/catalog/9853/how-people-learn-brain-mind-experience-and-school-expanded-edition
14. American Physical Society and the American Association of Physics Teachers. (2025). Implementing Research-Based Instructional Practices. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/implementing-research-based-instructional-practices
15. National Research Council. (1999). *How People Learn: Bridging Research and Practice.* National Academies Press, Washington, DC. https://nap.nationalacademies.org/catalog/9457/how-people-learn-bridging-research-and-practice
16. Boa, L. and Koenig, K. (2019). Physics education research for 21st century learning. *Disciplinary and Interdisciplinary Science Education Research* 1(2). https://doi.org/10.1186/s43031-019-0007-8
17. Kim, A.Y., Ton, V. and Vega, D. (2024). Changing person-environment fit among underrepresented undergraduate physics students: Success from a small department. *Phys Rev PER* 20, 010118. https://doi.org/10.1103/PhysRevPhysEducRes.20.010118
18. Freeman, S., Eddy, S.L., McDonough, M., et al. (2014). Active learning increases student performance in science, engineering and mathematics. *Proceedings of the National Academy of Sciences (PNAS)*, 111(23), 8410 – 8415. https://www.pnas.org/doi/full/10.1073/pnas.1319030111
19. Brookes, D.T., Etkina, E., and Planinsic, G. (2020). Implementing an epistemologically authentic approach to student-centered inquiry learning. *PhysRevPhysEducRes.* 16,020148. https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.16.020148
20. Oliveira, A., Behnagh, R.F., Ni, L., et al. (2019). Emerging technologies as pedagogical tools for teaching and learning science: A literature review. *Hum Behav & Emerg Tech.* 1, 149-160. https://onlinelibrary.wiley.com/doi/epdf/10.1002/hbe2.141
21. Makokha, J. (2017). Emerging Technologies and Science Teaching. In Taber, K.S. and Akpan, B. (eds). *Science Education, (369-383).* Sense Publishers, Rotterdam. https://www.researchgate.net/publication/312014547_Emerging_Technologies_and_Science_Teaching
22. Holmes, N.G., Keep, B., and Weiman, C.E. (2020). Developing scientific decision making by structuring and supporting student agency. *Phys Rev Phys Educ Res*. 16,010109. https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.16.010109
23. Holmes, N.G., Weiman, C.E., and Bonn, D.A. (2015). Teaching critical thinking. *Proceedings of the National Academy of Sciences (PNAS)*, 112(36), 11199-11204. www.pnas.org/cgi/doi/10.1073/pnas.1505329112

24. Etkina, E., Van Heuvelen, A., White-Brahmia, S., et al. (2006). Scientific abilities and their assessment. *Phys. Rev. STPER* 2, 020103. https://journals.aps.org/prper/abstract/10.1103/PhysRevSTPER.2.020103
25. Smith, E.M., Stein, M.M., Walsh, C. and Holmes, H.G. (2020). Direct Measurement of the Impact of Teaching Experimentation in Physics Labs. *Phys. Rev. X* 10.011029.
26. Docktor, J.L. and Mestre, J.P. (2014). Synthesis of discipline-based education research in physics. *Physical Review Special Topics – Physics Education Research, 10,* 020119. https://journals.aps.org/prper/pdf/10.1103/PhysRevSTPER.10.020119
27. American Physical Society and the American Association of Physics Teachers. (2025). Computational Skills. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/computational-skills
28. American Association of Physics Teachers. (2016). *AAPT Recommendations for Computational Physics in the Undergraduate Physics Curriculum*. https://www.aapt.org/Resources/upload/AAPT_UCTF_CompPhysReport_final_B.pdf
29. Atherton, T.J. (2023). Resource Letter CP-3: Computational physics. *Am. J. Phys.* 91, 7-27. https://doi.org/10.1119/5.0106476
30. Fredly, K.H., Odden, T.O.B. and Zwickl, B.M. (2026). Physics computational literacy: Programming, modeling, and collaboration at the journeyman level. *Phys. Rev. Phys. Educ. Res.* 22, 010103. https://doi.org/10.1103/6fny-yzyb
31. Varty, A.K. (2022). Promoting Achievement for Community College STEM Students through Equity-Minded Practices. *CBE-Life Sciences Education, 21,* 2. https://www.lifescied.org/doi/full/10.1187/cbe.21-09-0237
32. Martins, J.S., Belleau, S.N. and Otero, V.K. (2021). Julian S. Martins, Shelly N. Belleau, and Valerie K. Otero. PEER Physics: An evidence-based framework for inclusive physics curricula. *Phys. Teach. 59* (9), 730-731. https://pubs.aip.org/aapt/pte/article-abstract/59/9/730/278715/PEER-Physics-An-evidence-based-framework-for?redirectedFrom=fulltext
33. American Association of Physics Teachers. (2018). *Fostering Safe and Inclusive Learning Environments. https://www.aapt.org/Resources/policy/fostering_safe_inclusive_classrooms.cfm*
34. National Archives and Records Administration. (2026). Code of Federation Regulations, Title 34, Subtitle B, Chapter VI, Part 600, Subpart A §600.2. https://www.ecfr.gov/current/title-34/subtitle-B/chapter-VI/part-600/subpart-A/section-600.2
35. Eslami, M., Denaro, K., Collins, P. et al. (2024). How syllabi relate to outcomes in higher education: A study of syllabi learner-centeredness and grade inequities in STEM. *PLoS One 19* (4). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC11023273/
36. InTeGrate. (2017). *Interdisciplinary Teaching: Designing for Success.* Science Education Resource Center, Carleton College. https://serc.carleton.edu/190074
37. Redish, E.F., Sawtelle, V. and Turpen, C. (2014). The role physics can play in a multi-disciplinary curriculum for non-physics scientists and engineers. *Eur J Sci Math Ed, 2* (2A), 1-13. https://doi.org/10.30935/scimath/9621
38. Dorman, T., Oonge, H. and Minton, T. (2023). *Curriculum Alignment Handbook (2nd ed.)* University of Central Florida, Orlando. https://curriculumalignment.ucf.edu/document/curriculum-alignment-handbook/
39. Quality Matters, Virtual Learning Leadership Alliance, and The Community Advancing Digital Learning. (2025). *National Standards for Quality Online Teaching*. https://www.nsqol.org/the-standards/quality-online-teaching/
40. Quality Matters, Virtual Learning Leadership Alliance, and The Community Advancing Digital Learning. (2025). *National Standards for Quality Online Courses*. https://nsqol.org/the-standards/quality-online-courses/

41. Quality Matters. (2023). *Standards from the QM Higher Education Rubric*. https://www.qualitymatters.org/sites/default/files/PDFs/StandardsfromtheQMHigherEducationRubric.pdf
42. North American Council for Online Learning. (2006). *National Standards for Quality Online Teaching* (2006). https://files.eric.ed.gov/fulltext/ED509639.pdf
43. Chatzidaki, P., Eriksson, U., Zoechling, S. et al. (2025). What makes digital learning effective? Evaluation of a learning module about positron emission tomography. *Phys Rev Per* 21, 010143. https://doi.org/10.1103/PhysRevPhysEducRes.21.010143
44. Mupinga, D.M. and Maughan, G.R. (2008). Web-Based Instruction and Community College Faculty Workload. *College Teaching*, 56(1): 17-21. https://doi.org/10.3200/CTCH.56.1.17-22
45. Mandernach, B.J. and Holbeck, R. (2016). Teaching Online: Where Do Faculty Spend Their Time? *Online Journal of Distance Learning Administration*, XIX(4). https://ojdla.com/archive/winter194/mandernach_holbeck194.pdf
46. Dhilla, S.J. (2019). The role of online faculty in supporting successful online learning enterprises: A literature review. *Higher Education Politics & Economics,* 3(1). https://doi.org/10.32674/hepe.v3i1.12
47. The Chicago School University Library. (2025). *Best Practices for Textbook Selection*. https://library.thechicagoschool.edu/textbook-selection
48. Reid, P. and Maybee, C. (2022). Textbooks and Course Materials: A Holistic 5-Step Selection Process. *College Teaching,* 70(4), 518-529. https://doi.org/10.32674/hepe.v3i1.12
49. Snowman, A.K. (2017). Do textbooks have a place in the library? *Journal of Access Services,* 14(2):43-45. https://doi.org/10.1080/15367967.2017.1309246
50. Lai, J.W. and Cheong, K.H. (2022). Educational Opportunities and Challenges in Augmented Reality: Featuring Implementations in Physics Education. *IEEE Access,* 10, 43143-43158. https://ieeexplore.ieee.org/document/9755165
51. Banda, H.J. and Nzabahimana, J. (2021). Effect of integrating physics education technology simulations on students' conceptual understanding in physics: A review of literature. *Phys. Rev. Phys. Educ. Res.* 17, 023108. https://doi.org/10.1103/PhysRevPhysEducRes.17.023108
52. Thais, S. (2020). Physicists Must Engage with AI Ethics, Now. *Physics,* 13,107. American Physical Society. https://physics.aps.org/articles/v13/107
53. Wattanakasiwich, P., Kaewkhong, K. and Katwibun, D. (2025). Physics instructors' acceptance and implementation of generative AI. *Phys.Rev. Phys. Educa. Res.* 21, 010155. https://doi.org/10.1103/r2fn-kdy4
54. Tong, D., Jin, B., Tao, Y. et al. (2025). Exploring the role of human-AI collaboration in solving scientific problems. *Phys. Rev. Phys. Educ. Res.* 21,010149. https://doi.org/10.1103/PhysRevPhysEducRes.21.010149
55. The American Association of Physics Teachers, PhysPort, comPADRE, and National Science Digital Library. (2026). *PhysPort Assessment Resources*. https://www.physport.org/Assessment.cfm
56. American Physical Society and the American Association of Physics Teachers. (2025). How to Assess Student Learning at the Program Level. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/how-to-assess-student-learning
57. American Physical Society and the American Association of Physics Teachers. (2025). How to Select and Use Various Assessment Methods in Your Program. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/how-to-select-and-use-various-assessment-methods/
58. Riviere, J., Picard, D., & Coble, R. (2021). *Syllabus Design.* Lab Xchange. https://www.labxchange.org/library/items/lb:LabXchange:d7f01b4e:lx_teaching_guide:1

59. Center for Educational Innovation. (UD). *Course and Syllabus Design.* University of Minnesota. https://cei.umn.edu/teaching-resources/course-and-syllabus-design
60. Palmer, M.S., Wheeler, L.B. and Aneece, I. (2016). Does the Document Matter? The Evolving Role of Syllabi in Higher Education. *Change: The Magazine of Higher Learning* 48(4), 36-47. https://drive.google.com/file/d/17YeqMSHVK_aj2Me58zZNtSNgTJ-BWYkI/view
61. Stanford Teaching Commons. (UD). *Creating Learning Outcomes.* Stanford University. https://teachingcommons.stanford.edu/teaching-guides/foundations-course-design/course-planning/creating-learning-outcomes
62. Bao, L., Koenig, K., Xiao, Y. et al. (2022). Theoretical model and quantitative assessment of scientific thinking and reasoning. *Phys. Rev. Phys. Educa. Res.* 18, 010115. https://doi.org/10.1103/PhysRevPhysEducRes.18.010115
63. Docktor, J.L., Dornfeld, J., Frodermann, E. et al. (2016). Assessing student written problem solutions: A problem-solving rubric with application to introductory physics. *Phys. Rev. Phys. Educ. Res.* 12, 010130. https://doi.org/10.1103/PhysRevPhysEducRes.12.010130
64. Etkina, E., Van Heuvelen, A., White-Brahmia, S. et al. (2006). Scientific abilities and their assessment. *Phys. Rev. STPER* 2, 020103 (2006). https://journals.aps.org/prper/abstract/10.1103/PhysRevSTPER.2.020103
65. Columbia Center for Teaching and Learning (2022). Assessing Equitably with All Learners in Mind. Columbia University. https://ctl.columbia.edu/resources-and-technology/resources/assessing-equitably/
66. American Physical Society and the American Association of Physics Teachers. (2025). How to Undertake an Undergraduate Program Review. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/how-to-undertake-an-undergraduate-program-review#description
67. American Association of Physics Teachers. (2005). *Guidelines for Self-Study and External Evaluation of Undergraduate Physics Programs.* https://www.aapt.org/Resources/upload/Guide_undergrad.pdf

Section III: Laboratories

1. Beichner, R.J., Saul, J.M., Abbott, D.S. et al. (2007). The Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) Project. In *Research-Based Reform of University Physics, Vol. 1,* E. Redish and P. Cooney, eds. American Association of Physics Teachers. https://drive.google.com/file/d/1jItq6jtbpwbV90KCJey7_xcdPFiM6e2I/view
2. Freeman, S., Eddy, S.L., McDonough, M. et al. (2014). Active learning increases student performance in science, engineering and mathematics. *Proceedings of the National Academy of Sciences (PNAS)*, 111(23), 8410 – 8415. https://www.pnas.org/doi/full/10.1073/pnas.1319030111
3. Thacker, B. (2023). Beth Thacker. Inquiry-based experimental physics: Twenty years of an evidence-based, laboratory-based physics course for algebra-based physics students. PhysRevPhysEducRes. 19, 020116. https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.19.020116
4. Sulaiman, N. Werth, A. and Lewandowski, H.J. (2023). Students' views about experimental physics in a large-enrollment introductory lab focused on experimental scientific practices. PhysRevPhysEducRes. 19, 010116. https://doi.org/10.1103/PhysRevPhysEducRes.19.010116
5. Quan, G.M., Corbo, J.C., Finkelstein, N.D., et al. (2019). Designing for institutional transformation: Six principles for department-level interventions. PhysRevPhysEducRes. 15, 010141. https://doi.org/10.1103/PhysRevPhysEducRes.15.010141

6. AAPT Committee on Laboratories. (2014). *AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum.* American Association of Physics Teachers. https://www.aapt.org/Resources/upload/LabGuidlinesDocument_EBendorsed_nov10.pdf
7. Holmes, N.G. and Smith, E.M. (2019). Operationalizing the AAPT Learning Goals for the Lab. *Phys. Teach.* 57, 296-299. https://doi.org/10.1119/1.5098916
8. American Physical Society and the American Association of Physics Teachers. (2025). Instructional Laboratories and Experimental Skills. *EP3: Effective Practices for Physics Programs.* https://ep3guide.org/guide/instructional-laboratories-and-experimental-skills
9. Holmes, N.G. and Weiman, C.E. (2018). Introductory physics labs: We can do better. *Phys. Today* 71(1), 38–45. https://doi.org/10.1063/PT.3.3816
10. Holmes, N.G, Keep, B. and Wieman, C.E. (2020). Developing scientific decision making by structuring and supporting student agency. PhysRevPhysEducRes. 16,010109. https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.16.010109
11. Brewe, E. (2008). Modeling theory applied: Modeling Instruction in introductory physics. *Am.J.Phys.* 76(12), 1155-1160. https://doi.org/10.1119/1.2983148
12. Dounas-Frazer, D.R. and Lewandowski, H.J. (2018). The Modelling Framework for Experimental Physics: description, development, and applications. *Eur. J. Phys.* 39, 064005. https://doi.org/10.1088/1361-6404/aae3ce
13. Brewe, E., Sawtelle, V., Kramer, L.H. et al. (2010). Toward equity through participation in Modeling Instruction in introductory university physics. *Phys. Rev. ST Phys. Educ. Res.* 6, 010106. https://doi.org/10.1103/PhysRevSTPER.6.010106
14. Barth-Cohen, L., Gerton, J.M., Davenport, K. et al. (2025). Promoting Student Conceptual and Procedural Sensemaking in Introductory Physics Labs. *Phys. Teach.* 63, 324-327. https://doi.org/10.1119/5.0159520
15. Wilcox, B.R. and Lewandowski, H.J. (2017). Developing skills versus reinforcing concepts in physics labs: Insight from a survey of students' beliefs about experimental physics. *Phys. Rev. PER* 13, 010108. https://doi.org/10.1103/PhysRevPhysEducRes.13.010108
16. Smith, E.M., Stein, M.M., Walsh, C., and Holmes, N.G. (2020). Emily M. Smith, Martin M. Stein, Cole Walsh and N.G. Holmes. Direct Measurement of the Impact of Teaching Experimentation in Physics Labs. *Phys.Rev.X* 10, 011029. https://doi.org/10.1103/PhysRevX.10.011029
17. Walsh, C. Lewandowski, H.J., and Holmes, N.G. (2022). Lewandowski, and N.G. Holmes. Skills-focused lab instruction improves critical thinking skills and experimental views for all students. *Phys. Rev. Phys. Educ. Res.* 18, 010128. https://doi.org/10.1103/PhysRevPhysEducRes.18.010128
18. Pollard, B., Werth, A., Hobbs, R. and Lewandowski, H.J. (2020). Impact of a course transformation on students' reasoning about measurement uncertainty. *Phys. Reve. Phys. Educ. Res.* 16, 020160. https://doi.org/10.1103/PhysRevPhysEducRes.16.020160
19. Heron, P. and McNeil, L. (2016). Phys21: Preparing Physics Students for 21st-Century Careers. *Joint Task Force on Undergraduate Physics Programs, American Physical Society and the American Association of Physics Teachers*. https://www.compadre.org/jtupp/docs/J-Tupp_Report.pdf
20. Pols, C.F.J. and Dekkers, P.J.J.M. (2024). Redesigning a first year physics lab course on the basis of the procedural and conceptual knowledge in science model. *Phys. Rev. Phys. Educ. Res.* 20, 010117. https://doi.org/10.1103/PhysRevPhysEducRes.20.010117
21. Geshwind, G., Vignal, M., Caballero, M.D. and Lewandowski, H.J. (2024). Using a research-based assessment instrument to explore students' proficiencies around measurement uncertainty in physics lab contexts. *Phys. Rev. Phys. Educ. Res.* 20, 020105. https://doi.org/10.1103/PhysRevPhysEducRes.20.020105

22. American Physical Society and the American Association of Physics Teachers. (2025). Computational Skills. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/computational-skills
23. American Association of Physics Teachers. (2016). *AAPT Recommendations for Computational Physics in the Undergraduate Physics Curriculum.* https://www.aapt.org/Resources/upload/AAPT_UCTF_CompPhysReport_final_B.pdf
24. Athereon, T.J. (2023). Timothy J. Atherton. Resource Letter CP-3: Computational physics. *Am. J. Phys.* 91, 7-27. https://doi.org/10.1119/5.0106476
25. Bugge, D. (2023). Improving scientific abilities through lab report revision in a high school investigative science learning environment classroom. *Phys. Rev. Phys. Educ. Res.* 19, 020166. https://doi.org/10.1103/PhysRevPhysEducRes.19.020166
26. Hoehn, J.R. and Lewandowski, H.J. (2020). Framework of goals for writing in physics lab classes. *Phys. Rev. Phys. Educ. Res.* 16, 010125. https://doi.org/10.1103/PhysRevPhysEducRes.16.010125
27. Brinson, J.R. (2015). Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: A review of the empirical research. *Computers and Education,* 87, 218-237. https://doi.org/10.1016/j.compedu.2015.07.003
28. Post, L.S., Guo, P., Saab, N. and Admiraal, W. (2019). Effects of remote labs on cogenitive, behavioral, and affective learning outcomes in higher education. *Computers and Education,* 140, 103596. https://doi.org/10.1016/j.compedu.2019.103596
29. Moosvi, F., Reinsberg, S.A. and Reiger, G.W. (2019). Can a Hands-On Physics Project Lab be Delivered Effectively as a Distance Lab? International Review of Research in Open and Distributed Learning, 20(1). https://files.eric.ed.gov/fulltext/EJ1207473.pdf
30. Zwiers, G.M., Piehl, C.G. and Polik, W.F. (2025). Before the Next Pandemic: Development a Framework for Assessing Online Labs to Maximize Student Experience. *Michigan Academician.* Accessed through Academic Search Ultimate. https://research-ebsco-com.proxy-um.researchport.umd.edu/c/jbv2fl/viewer/pdf/hjblygf5rb
31. West, R.E., Sansom, R., Nielson, J. et al. (2021). Ideas for supporting student-centered stem learning through remote labs: a response. *Education Tech Research Dev,* 69, 263-268. https://doi.org/10.1007/s11423-020-09905-y
32. Rosen, D. J. and Kelly, A.M. (2022). Working together or alone, near, or far: Social connections and communities of practice in in-person and remote physics laboratories. *Phys Rev Phys Educ Res*, 18, 010105. https://doi.org/10.1103/PhysRevPhysEducRes.18.010105
33. Strubbe, L. and McKagan, S. (2025). I suddenly have to move my lab course online! What should I do? *PhysPort, Expert Recommendations.* *https://www.physport.org/recommendations/Entry.cfm?ID=119927*
34. Singer, S.R., Hilton, M.L. and Schweingruber, H.A., Eds. (2026). Teacher and School Readiness for Laboratory Experiences. *America's Lab Report.* Ch. 5, 138-167. National Academies Press, Washington, DC. https://nap.nationalacademies.org/read/11311/chapter/7#149
35. Dana, L.M., Pollard, B. and Mueller, S. (2023). Professional contexts of physics instructional labs: More than technical support. *Phys. Rev. Phys. Educ. Res.* 19, 020127. https://doi.org/10.1103/PhysRevPhysEducRes.19.020127
36. Boyd, B.N. (2015). Laboratory Workload Calculation and its Impact on Science Instruction at the Community College Level. *Journal of College Science Teaching*, 44(5), 82-91. https://www.jstor.org/stable/43631854
37. American Chemical Society. (2025). ACS Guidelines for Chemistry in Two-Year College Programs. https://www.acs.org/education/policies/two-year-college/guidelines.html

38. National Association of Biology Teachers. (2019). NABT Guidelines for the Evaluation of Two-Year Undergraduate Biology. https://nabt.org/files/galleries/Guidelines_for_the_Evaluation_of_2Y_UG_Biology.pdf
39. Ketonen, L., Lehtinen, A. and Koskinen P. (2023). Assessment designs of instructional labs: A literature review and a design model. *Phys. Rev. Phys. Educ. Res.* 19, 020601. https://doi.org/10.1103/PhysRevPhysEducRes.19.020601
40. Xiong-Skiba, P., Buckner, S., Little, C. and Kovalskiy, A. (2020). Replacing Lab Report Grading by Online Lab Quizzes. *Phys. Teach.* 58, 55-57. https://doi.org/10.1119/1.5141975
41. Sobhanzadeh, M. and Zizler, P. (2021). Selective Assessment in Introductory Physics Laboratorials. *Phys. Teach.* 59, 114-116. https://doi.org/10.1119/10.0003465
42. Veazey, J.P. (2024). Piecewise Grading Reform Year 1: Lab Specifications. *Phys. Teach.* 62, 721-724. https://doi.org/10.1119/5.0180071
43. The American Association of Physics Teachers, PhysPort, comPADRE, and National Science Digital Library. (2026). *PhysPort Assessment Resources*. https://www.physport.org/Assessment.cfm
44. American Physical Society and the American Association of Physics Teachers. (2025). The Physical Environment: Encouraging Collaboration and Learning. *EP3: Effective Practices for Physics Programs.* https://ep3guide.org/guide/physical-environment-encouraging-collaboration-and-learning
45. National Science Teaching Association. (2024). *Liability of Science Educators for Laboratory Safety.* https://www.nsta.org/nstas-official-positions/liability-science-educators-laboratory-safety
46. NSTA Safety Advisory Board. (2020). *Overcrowding in the Instructional Space.* National Science Teaching Association. https://static.nsta.org/pdfs/overcrowdingintheinstructionalspace.pdf
47. Dounas-Frazer, D.R., Gillen, D., Herne, C.M. et al. (2021). *Increase Investment in Accessible Physics Labs: A Call to Action for the Physics Education Community.* American Association of Physics Teachers. https://www.aapt.org/aboutaapt/organization/upload/white_paper_on_accessible_labs_endorsed.pdf

Section IV: Student Support

1. Cheryan, S., Ziegler, S.A., Plaut, V.C. and Meltzoff, A.N. (2014). Designing Classrooms to Maximize Student Achievement. *Policy Insights from the Behavioral and Brain Sciences,* 1(1). https://doi.org/10.1177/2372732214548677
2. American Association of Community Colleges. (2026). *Fast Facts 2026. https://www.aacc.nche.edu/wp-content/uploads/securepdfs/2026/03/AACC2026_Fast_Fact_Sheet.pdf*
3. Monroe, M.B., O'Kuma, T.L. and Hein, W.; Norton, M.J. Ed. (2005). *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* (*SPIN-UP/TYC)* The American Association of Physics Teachers, College Park, MD. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf
4. Walker, K.N. and Dancy, M.H. (2007). Investigation and Evaluation of a Physics Tutorial Center. *AIP Conf. Proc.* 883, 137-140. https://doi.org/10.1063/1.2508711
5. Borger, L., Camarato, M.J. and Fisher, M.H. (2024). An Analysis of Graduate Teaching Assistants' Noticing Skills During Calculus and Physics Tutoring Scenarios. *Mathematics Enthusiast,* 21(1&2), 357-376. Accessed through Academic Search Ultimate. https://research-ebsco-com.proxy-um.researchport.umd.edu/c/jbv2fl/viewer/pdf/x6kdxogm3v

6. N. Person, A. Graesser, J. Magliano, and R. Kreuz. (1994). Inferring what the student knows in one-to-one tutoring: The role of student questions and answers. *Learning and Individual Differences,* 6, 205. https://doi.org/10.1016/1041-6080(94)90010-8
7. Otero, V., Pollock, S. and Finkelstein, N. (2010). A physics department's role in preparing physics teachers: The Colorado Learning Assistant model. *Am. J. Phys.* 78, 1218. https://dx.doi.org/10.1119/1.3471291
8. Close, E.W., Conn, J. and Close, H.G. (2016). Becoming physics people: Development of integrated physics identity through the Learning Assistant experience. *Phys. Rev. Phys. Educ. Res.* 12, 010109. https://doi.org/10.1103/PhysRevPhysEducRes.12.010109
9. Chaves, S., Lee, V., Morris, S. et al. (2023). An Embedded Tutoring Model. *The Learning Assistant Review,* 28(2), 151-185. https://eric.ed.gov/?q=source%3A%22Learning+Assistance+Review%22&ff1=locMaryland&id=EJ1412501
10. Brown, A.M. (2024). Supporting Classroom Success: An Embedded Tutor Model and Inclusive Teaching Techniques. *The National Teaching & Learning Forum,* 33(5), 1-3. https://doi-org.proxy-um.researchport.umd.edu/10.1002/ntlf.30409
11. Guthrie, M.W., Wu, X. and Scanlon, E.M. (2025). Supporting Effective and Inclusive Group Work in Introductory Physics Courses: A Guide for Instructors. *Phys. Teach.* 63, 629-632. https://doi.org/10.1119/5.0175809
12. Kathleen M. Koenig, Robert J. Endorf, and Gregory A. Braun. (2007). Effectiveness of different tutorial recitation teaching methods and its implications for TA training. *Phys. Rev. ST Phys. Educ. Res.* 3, 010104. https://doi.org/10.1103/PhysRevSTPER.3.010104
13. Mason, A.J. and Singh, C. (2026). Impact of Guided Reflection with Peers on the Development of Effective Problem Solving Strategies and Physics Learning. *Phys. Teach.* 54, 295-299. https://doi.org/10.1119/1.4947159
14. Gjerde, V. and Hagane, S. (2024). Enhancing peer instruction in physics: Understanding cognitive processes and refining rules. *Phys. Rev. Phys. Educ. Res.* 20, 010134. https://doi.org/10.1103/PhysRevPhysEducRes.20.010134
15. Bickel, J.E., Bunnell, L.M. and Heus, T. (2021). Utilizing peer teaching and reflection on low-stakes quizzes to improve learning outcomes in introductory calculus-based physics classes. *Eur. J. Physics.* 42, 055701. https://iopscience-iop-org.proxy-um.researchport.umd.edu/article/10.1088/1361-6404/ac0321/pdf
16. Brundage, M.J., Malespina, A. and Singh, C. (2023). Peer interaction facilitates co-construction of knowledge in quantum mechanics. *Phys. Rev. Phys. Educ. Res.* 19, 020133. https://doi.org/10.1103/PhysRevPhysEducRes.19.020133
17. Mason, A. and Singh, C. (2010). Helping students learn effective problem solving strategies by reflecting with peers. *Am. J. Phys.* 78, 748-754. https://doi.org/10.1119/1.3319652
18. Dunleavy, S., Kestin, G., Callahan, K. et al. (2022). Increased learning in a college physics course with timely use of short multimedia summaries. *Phys. Rev. Phys. Educ. Res.* 18, 010110. https://doi.org/10.1103/PhysRevPhysEducRes.18.010110
19. Inglesias, V. (2018). Beyond the mandates: The far-reaching benefits of multimedia accessibility. *Learned Publishing,* 31, 49-54. https://doi.org/10.1002/leap.1153
20. Monroe, M.B., O'Kuma, T.L. and Hein, W.; Norton, M.J. Ed. (2005). Chapter 3: Best Practices and Chapter 5: Project Findings. *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* American Associate of Physics Teachers. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf

21. Stiles-Clarke, L. and MacLeod, K. (2025). Moving toward belonging in a physics department: What changes are possible with and without a paradigm shift? *Phys. Rev. Phys. Educ. Res.* 21, 010114. https://doi.org/10.1103/PhysRevPhysEducRes.21.010114
22. Kim, A.Y., Ton, V., and Vega, D. (2024). Changing person-environment fit among underrepresented undergraduate physics students: Successes from a small department. *Phys. Rev. Phys. Educ. Res.* 20, 010118. https://doi.org/10.1103/PhysRevPhysEducRes.20.010118
23. Li, Y. and Singh, C. (2023). Sense of belonging is an important predictor of introductory physics students' academic performance. *Phys. Rev. Phys. Educ. Res.* 19, 020137. https://doi.org/10.1103/PhysRevPhysEducRes.19.020137
24. American Physical Society and the American Association of Physics Teachers. (2025). Advising and Mentoring of Students. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/advising-and-mentoring-of-students/
25. American Physical Society and the American Association of Physics Teachers. (2025). The Physical Environment: Encouraging Collaboration and Learning. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/physical-environment-encouraging-collaboration-and-learning/
26. Zwolak, J.P., Dou, R., Williams, E.A. and Brewe, E. (2017). Students' network integration as a predictor of persistence in introductory physics courses. *Phys. Rev. Phys. Educ. Res.* 13, 010113. https://doi.org/10.1103/PhysRevPhysEducRes.13.010113
27. Lauricella, S., Kay, R.H. and Craig, C.D. (2023). Examining the Benefits and Challenges of Using Discord in Online Higher Education Classrooms. *Journal of Educational Informatics,* 4(2), 20-31. https://doi.org/10.51357/jei.v4i2.225
28. Forrest, R.L., Stokes, D.W., Burridge, A.B. and Voight, C.D. (2017). Math remediation intervention for student success in the algebra-based introductory physics course. *Phys. Rev. Phys. Educ. Res.* 13, 020137. https://doi.org/10.1103/PhysRevPhysEducRes.13.020137
29. Shafer, D., Girotti-Hernandez, D. and Stelzer, T. (2024). Evolving study strategies and support structures of introductory physics students. *Phys. Rev. Phys. Educ. Res.* 20, 020114. https://doi.org/10.1103/PhysRevPhysEducRes.20.020114
30. American Physical Society and the American Association of Physics Teachers. (2025). Guide to Equity, Diversity and Inclusion. *EP3: Efffective Practices for Physics Programs.* https://ep3guide.org/guide/equity-diversity-and-inclusion
31. Webb, D.J. and Paul, C.A. (2023). Attributing equity gaps to course structure in introductory physics. *Phys. Rev. Phys. Educ. Res.* 19, 020126. https://doi.org/10.1103/PhysRevPhysEducRes.19.020126
32. Gjerde, V., Holst, B. and Kolstø, S.D. (2021). Integrating effective learning strategies in basic physics lectures: A thematic analysis. *Phys. Rev. Phys. Educ. Res.* 17, 010124. https://doi.org/10.1103/PhysRevPhysEducRes.17.010124
33. Dancy, M. (2025). Majority group physics instructors struggle to notice, name and disrupt racist and sexist student interactions. *Phys. Rev. Phys. Educ. Res.* 21, 010142. https://doi.org/10.1103/PhysRevPhysEducRes.21.010142
34. Santana, L.M. and Singh, C. (2023). Effects of male-dominated physics culture on undergraduate women. *Phys. Rev. Phys. Educ. Res.* 19, 020134. https://doi.org/10.1103/PhysRevPhysEducRes.19.020134
35. Kalendar, Z.Y., Marshman, E., Schunn, C.D. et al. (2022). Framework for unpacking students' mindsets in physics by gender. *Phys. Rev. Phys. Educ. Res.* 18, 010116. https://doi.org/10.1103/PhysRevPhysEducRes.18.010116

36. Kim, A.Y., Ton, V. and Vega, D. (2024). Changing person-environment fit among underrepresented undergraduate physics students: Success from a small department. *Phys Rev PER* 20, 010118. https://doi.org/10.1103/PhysRevPhysEducRes.20.010118
37. Zook, G.F., Blanding, S.G., McConnell, T.R., et al. (1947). Chapter II: Education for All. *Higher Education for American Democracy: A Report of the President's Commission on Higher Education, Vol. 1.* U.S. Government Printing Office, Washington, DC. *https://play.google.com/books/reader?id=wvCcAAAAMAAJ&pg=GBS.PR1&hl=en*
38. Keblbeck, D.K., Piatek-Jimenez, K. and Medina, C.M. (2024). Undergraduate physics students' experiences: Exploring the impact of underrepresented identities and intersectionality. *Phys. Rev. Phys. Educ. Res.* 20, 020120. https://doi.org/10.1103/PhysRevPhysEducRes.20.020120
39. Zhang, L., Swirtz, M. and Nordstrom, K. (2025). Physics identity of Asian identified US college students. *Phys. Rev. Phys. Educ. Res.* 21, 010110. https://doi.org/10.1103/PhysRevPhysEducRes.21.010110
40. American Physical Society and the American Association of Physics Teachers. (2025). The Physical Environment: Encouraging Collaboration and Learning. *EP3: Effective Practices for Physics Programs.* https://ep3guide.org/guide/physical-environment-encouraging-collaboration-and-learning
41. Dounas-Frazer, D.R., Gillen, D., Herne, C.M. et al. (2021). *Increase Investment in Accessible Physics Labs: A Call to Action for the Physics Education Community.* American Association of Physics Teachers. https://www.aapt.org/aboutaapt/organization/upload/white_paper_on_accessible_labs_endorsed.pdf
42. James, W., Bustamante, C., Lamons, K., Scanlon, K. and Chini, J.J. (2020). Disabling barriers experienced by students with disabilities in postsecondary introductory physics. *Phys. Rev. Phys. Educ. Res.* 16, 020111. https://doi.org/10.1103/PhysRevPhysEducRes.16.020111
43. Universal Design for Learning. (2024). *The UDL Guidelines*. https://udlguidelines.cast.org/
44. Guthrie, M.W., Wu, X., Scanlon, E.M. et al. (2025). "The system wasn't designed for us": Experiences of five disabled physics students. *Phys. Teach.* 63, 386-387. https://doi.org/10.1119/5.0273259
45. Kamalumpundi, V., Silvers, S., Franklin, L. et al. (2023). Speaking up for the invisible minority: First-generation students in higher education. *J Cell Physiol.* 239:e31158. https://doi.org/10.1002/jcp.31158
46. Community College Research Center. (2025). *An Introduction to Community Colleges and Their Students.* Teachers College, Columbia University, New York, New York. https://ccrc.tc.columbia.edu/publications/an-introduction-to-community-colleges-and-their-students.html
47. Shurtleff, C. (2024). From Food Pantry to CARE Center in a Rural College: Our Journey. *New Directions for Community Colleges 2024,* 37-44. https://doi.org/10.1002/cc.20650
48. American Physical Society and the American Association of Physics Teachers. (2025). Advising and Mentoring of Students. *EP3: Efffective Practices for Physics Programs.* https://ep3guide.org/guide/advising-and-mentoring-of-students/

Section V: Personnel

1. Monroe, M.B., O'Kuma, T.L. and Hein, W.; Norton, M.J., Ed. (2005). Chapter 3: Best Practices. *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* American Association of Physics Teachers. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf

2. American Physical Society and the American Association of Physics Teachers. (2025). Supporting Research-Based Teaching in Your Department. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/supporting-research-based-teaching-in-department/
3. American Physical Society and the American Association of Physics Teachers. (2025). How to Be an Effective Chair. *EP3: Effective Practices for Physics Programs.* https://ep3guide.org/guide/how-to-be-an-effective-chair
4. American Chemical Society. (2025). *ACS Guidelines for Chemistry in Two-Year College Programs*. https://www.acs.org/education/policies/two-year-college/guidelines.html
5. National Association of Biology Teachers. (2019). *NABT Guidelines for the Evaluation of Two-Year Undergraduate Biology*. https://nabt.org/files/galleries/Guidelines_for_the_Evaluation_of_2Y_UG_Biology.pdf
6. Council for Higher Education Accreditation. (2025). *Directory of CHEA-Recognized Accrediting Organizations*. https://www.chea.org/directory-chea-recognized-accrediting-organizations-pdf
7. Monroe, M.B., O'Kuma, T.L. and Hein, W.; Norton, M.J. Ed. (2005). Chapter 5: Project Findings. *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* American Association of Physics Teachers. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf
8. American Physical Society and the American Association of Physics Teachers. (2025). Guide to Equity, Diversity and Inclusion. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/equity-diversity-and-inclusion
9. American Physical Society and the American Association of Physics Teachers. (2025). Guide to Departmental Culture and Climate. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/departmental-culture-and-climate
10. Mafu, M. and Mazhandu, F. (2025). Leveraging Equity and Inclusion to Demystify and Diversify Quantum Science Education. *Phys. Teach.* 63, 90-94. https://doi.org/10.1119/5.0231016
11. Palmer, R.T., Maramba, D.C. and Dancy, T.E. (2011). A qualitative investigation of factors promoting the retention and persistence of students of color in STEM. *Journal of Negro Education*, 80(4), 491-504. https://www.academia.edu/download/102640913/download.pdf
12. Lewis, K.L., Stout, J.G., Pollock, S.J. et al. (2016). Fitting in or opting out: A review of key social-psychological factors influencing a sense of belonging for women in physics. *Phys. Rev. Phys. Educ. Res.* 12, 020110. https://doi.org/10.1103/PhysRevPhysEducRes.12.020110
13. Towns, M.H. (2010). Where Are the Women of Color? Data on African American, Hispanic and Native American Faculty in STEM. *Journal of College Science Teaching,* 39(4), 8-9. https://research-ebsco-com.proxy-um.researchport.umd.edu/c/jbv2fl/viewer/pdf/jyftlch2tv
14. Kimberly P. Hardy and Beverly L. Bower. (2004). Instructional and Work Life Issues for Distance Learning Faculty. *New Directions for Community Colleges,* 128, 47-54. https://doi.org/10.1002/cc.174
15. Wahab, N.Y.A., Rahman, R.A., Mahat, H. et al. (2024). Impacts of Workload on Teachers' Well-Being: A Systematic Literature Review. *TEM Journal,* 13(3), 2544-2556. https://doi.org/10.18421/TEM133-80
16. Zhang, X., Li, S., Wang, S. and Xu, J. (2022). Influence of job environment on the online teaching anxiety of college teachers in the online teaching context: The mediating role of subjective well-being. *Frontiers in Public Health,* 13,10. https://doi.or/10.3389/fpubh.2022.978094
17. O'Meara, K., Culpepper, D., Misra, J. and Jaegar, A. (2022). *Equity-Minded Faculty Workloads: What We Can and Should Do Now.* American Council on Education, Washington, DC. https://www.acenet.edu/Documents/Equity-Minded-Faculty-Workloads.pdf

18. Williamson, T., Goodwin, R. and Ubel, P.A. (2021). Minority Tax Reform - Avoiding Overtaxing Minorities When We Need Them Most. *N. Engl. J. Med* 384,20 (1877-1879). https://doi.org/10.1056/NEJMp2100179
19. Meredith, M., and Zhang, Y.L. (2024). Impact of Part-Time Faculty on Community College Student Success: An Analysis of Literature Using Foucault's Three Modes of Objectification. *New Directions for Community Colleges 2024,* 71-79. https://doi.org/10.1002/cc.20654
20. Carrier, J.W., Perkins, M.A. and DeDiego, A.C. (2022). Exploring Relationships Between Full-Time Faculty and Community College Student Success. *Community College Journal of Research and Practice,* 47(9), 608-611. https://doi.org/10.1080/10668926.2022.2156634
21. Zhu, M. (2021). Limited contracts, limited quality? Effects of adjunct instructors on student outcomes. *Economics of Education Review* 2021, 102177. https://doi.org/10.1016/j.econedurev.2021.102177
22. Yu, H., Bohlig, E.M. and Zhang, Y.L. (2023). A longitudinal examination: association between part-time faculty and student academic achievement at public two-year colleges. *Studies in Higher Education* 48(6), 829-844. https://doi.org/10.1080/03075079.2023.2172152
23. Thirolf, K.Q. and Woods, R.S. (2018). Contingent Faculty at Community College: The Too-Often Overlooked and Under-Engaged Faculty Majority. *New Directions for Institutional Research,* 176**,** 55-66. https://doi.org/10.1002/ir.20244
24. Layou, K.M., Goering, A.E., James, B.R. et al. (2022). Power and potential: Engaging adjunct faculty as leaders and agents of change. *New Directions for Community Colleges* 2022, 133-147. https://doi.org/10.1002/cc.20529
25. Bickerstaff, S. and Ran, F.X. (2020). How Did Six Community Colleges Design Supports for Part-Time Faculty? *Community College Research Center,* Teachers College, Columbia University, New York. https://ccrc.tc.columbia.edu/publications/six-community-colleges-supports-part-time-faculty.html
26. Zoromski, K. and Sasso, P.A. (2024). Transactional and Stopgap Relationships Between Community College Department Chairs and Their Adjuncts. *Community College Review* 52(20), 210-230. https://doi.org/10.1177/00915521231218239
27. Gordon, B. and Shane, S. (2024). Small Wins, Big Impact: Cultivating a Thriving Classroom for Teachers and Students. *Techniques,* 99(7), 14-17. https://research-ebsco-com.proxy-um.researchport.umd.edu/c/jbv2fl/viewer/pdf/q4hkamkf3b
28. McNamee, T.C. and Van Horn, A.D. (2024). Faculty Development at Community Colleges in U.S. Rural Contexts. *Journal of Education Human Resources,* 42(1), 67-87. https://doi.org/10.3138/jehr-2023-0051
29. Eddy, P.L., Hao, Y., Inverson, E. and Macdonald, R.H. (2022). Fostering Communities of Practice Among Community College Science Faculty. *Community College Review,* 50(4), 391-414. https://doi.org/10.1177/00915521221111474
30. Macaluso, R., Amaro-Jiménez, C., Patterson, O.K. et al. (2021). Engaging Faculty in Student Success: The Promise of Active Learning in STEM Faculty Professional Development. *College Teaching* 69,2 (113-119). https://doi.org/10.1080/87567555.2020.1837063
31. Lui,K.P.H., O'Kuma, T. and Hillborn, R. (2021). Linking physics in two-year colleges and physics professional societies. *New Directions for Community Colleges,* 113-124. https://doi.org/10.1002/cc.20457
32. Yerushalmi, E. and Eylon, B. (2013). Supporting teachers who introduce innovations into their classrooms: A problem-solving perspective. *Phys. Rev. ST PER* 9, 010121. https://doi.org/10.1103/PhysRevSTPER.9.010121

33. Dancy, M., Henderson, C., Apkarian, N. et al. (2024). Physics instructors' knowledge and use of active learning has increased over the last decade but most still lecture too much. *Phy. Rev. Phys. Educ. Res.* 20, 010119. https://doi.org/10.1103/PhysRevPhysEducRes.20.010119
34. Affriyenni, Y., Georgiou, H. and Finkelstein, N. (2025). Navigating the adoption of research-based instructional strategies within the complex nature of higher education. *Phy. Rev. Phys. Educ. Res.* 21, 020124. https://doi.org/10.1103/wvjk-8y8k
35. Charles Henderson and Melissa H. Dancy. (2007). Barriers to the use of research-based strategies: The influence of both individual and situational characteristics. *Phys. Rev. ST PER* 3, 020102. https://doi.org/10.1103/PhysRevSTPER.3.020102
36. American Physical Society and the American Association of Physics Teachers. (2025). Implementing Research-Based Teaching in Your Classroom. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/implementing-research-based-teaching-in-classroom/
37. Dana, L.M., Pollard, B. and Mueller, S. (2023). Professional contexts of physics instructional labs: More than technical support. *Phys. Rev. Phys. Educ. Res.* 19, 020127. https://doi.org/10.1103/PhysRevPhysEducRes.19.020127
38. American Chemical Society. (2025). *ACS Guidelines for Chemistry in Two-Year College Programs*. https://www.acs.org/education/policies/two-year-college/guidelines.html
39. National Association of Biology Teachers. (2019). NABT Guidelines for the Evaluation of Two-Year Undergraduate Biology. https://nabt.org/files/galleries/Guidelines_for_the_Evaluation_of_2Y_UG_Biology.pdf
40. Brown, A.M. (2024). Supporting Classroom Success: An Embedded Tutor Model and Inclusive Teaching Techniques. *The National Teaching & Learning Forum,* 33(5) 1-3. https://doi-org.proxy-um.researchport.umd.edu/10.1002/ntlf.30409
41. Holmes, N.G. and Smith, E.M. (2019). Operationalizing the AAPT Learning Goals for the Lab. *Phys. Teach.* 57, 296-299. https://doi.org/10.1119/1.5098916
42. American Physical Society and the American Association of Physics Teachers. (2025). Instructional Laboratories and Experimental Skills. *EP3: Effective Practices for Physics Programs.* https://ep3guide.org/guide/instructional-laboratories-and-experimental-skills

VI: Facilities

1. American Physical Society and the American Association of Physics Teachers. (2025). Supplement: Connecting Desired Student Behaviors and Optimal Spaces. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide-overview/connecting-desired-student-behaviors/
2. Cheryan, S., Ziegler, S.A., Plaut, V.C. and Meltzoff, A.N. (2014). Designing Classrooms to Maximize Student Achievement. *Policy Insights from the Behavioral and Brain Sciences,* 1, 1. https://doi.org/10.1177/2372732214548677
3. Monroe, M. B., O'Kuma, T.L. and Hein, W.; Norton, M.J. Ed. (2005). Chapter 5: Project Findings. *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* American Associate of Physics Teachers. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf
4. American Physical Society and the American Association of Physics Teachers. (2025). Instructional Laboratories and Experimental Skills. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/instructional-laboratories-and-experimental-skills/
5. U.S. Department of Justice, Civil Rights Division. (2010). 2010 ADA Standards for Accessible Design. https://www.ada.gov/law-and-regs/design-standards/2010-stds/

6. James, W., Bustamante, C., Lamons, K. et al. (2020). Disabling barriers experienced by students with disabilities in postsecondary introductory physics. *Phys. Rev. Phys. Educ. Res.* 16, 020111. https://doi.org/10.1103/PhysRevPhysEducRes.16.020111
7. CAST. (2024). Universal Design for Learning Guidelines version 3.0. https://udlguidelines.cast.org
8. Severo de Borba, G., Alves, I.M., and Dal Bó Campagnolo, P. (2020). How Learning Spaces Can Collaborate with Student Engagement and Enhance Student-Faculty Interaction in Higher Education. *Innovative Higher Education,* 45, 51-63. https://doi.org/10.1007/s10755-019-09483-9
9. Vercellotti, M.L. (2017). Do interactive learning spaces increase student achievement? A comparison of classroom context. *Active Learning in Higher Education,* 19, 3 (2017). https://doi.org/10.1177/1469787417735606
10. Kestin, G., Miller, K., McCarty, L.S. et al. (2020). Comparing the effectiveness of online versus live lecture demonstrations. *Phys. Rev. Phys. Educ. Res.* 16, 013101. https://doi.org/10.1103/PhysRevPhysEducRes.16.013101
11. Hilborn, R.C., Howes, R.H. and Krane, K.S., Eds. (2003). Chapter 4: Analysis. *Strategic Programs for Innovations in Undergraduate Physics: Project Report.* American Association of Physics Teachers, College Park, MD. https://www.aapt.org/Programs/projects/spinup/upload/SPIN-UP-Final-Report.pdf
12. Guthrie, M.W., Wu, X. and Scanlon, E.M. (2025). Supporting Effective and Inclusive Group Work in Introductory Physics Courses: A Guide for Instructors. *The Physics Teacher,* 63, 629-624. https://doi.org/10.1119/5.0175809
13. American Chemical Society. (2025). *ACS Guidelines for Chemistry in Two-Year College Programs*. https://www.acs.org/education/policies/two-year-college/guidelines.html
14. National Association of Biology Teachers. (2019). *Guidelines for the Evaluation of Two-Year Undergraduate Biology* (2019). *https://nabt.org/files/galleries/Guidelines_for_the_Evaluation_of_2Y_UG_Biology.pdf*
15. American Physical Society and the American Association of Physics Teachers. (2025). The Physical Environment: Encouraging Collaboration and Learning. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/physical-environment-encouraging-collaboration-and-learning/
16. Monroe, M. B., O'Kuma, T.L. and Hein, W.; Norton, M.J. Ed. (2005). Chapter 3: Best Practices. *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* American Associate of Physics Teachers. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf
17. American Physical Society and the American Association of Physics Teachers. (2025). Equity, Diversity, and Inclusion. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/equity-diversity-and-inclusion/

VII: Budget

1. American Physical Society and the American Association of Physics Teachers. (2025). How to be an Effective Chair. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/how-to-be-an-effective-chair/#effective-practices
2. Brewe, E., Dou, R. and Shand, R. (2018). Costs of success: Financial implications of implementation of active learning in introductory physics courses for students and administrators. *Phys. Rev. Phys. Educ. Res.* 14, 010109. https://doi.org/10.1103/PhysRevPhysEducRes.14.010109
3. American Physical Society and the American Association of Physics Teachers. (2025). Introductory Courses for STEM Majors. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/intro-courses-for-stem-majors/

4. American Physical Society and the American Association of Physics Teachers. (2025). Courses for Non-STEM Majors. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/courses-for-non-stem-majors/
5. Monroe, M. B., O'Kuma, T.L. and Hein, W.; Norton, M.J. Ed. (2005). Chapter 5: Project Findings. *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* American Associate of Physics Teachers. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf
6. American Chemical Society. (2025). *ACS Guidelines for Chemistry in Two-Year College Programs*. https://www.acs.org/education/policies/two-year-college/guidelines.html
7. Griffiths, R., Mislevy, J., Wang, S. et al. (2020). OER at Scale: The Academic and Economic Outcomes of Achieving the Dream's OER Degree Initiative. SRI International, Menlo Park, CA. https://achievingthedream.org/wp-content/uploads/2022/05/atd_oer_at_scale_academic_economic_outcomes_feb_2020.pdf
8. National Association of Biology Teachers. (2019). *NABT Guidelines for the Evaluation of Two-Year Undergraduate Biology*. https://nabt.org/files/galleries/Guidelines_for_the_Evaluation_of_2Y_UG_Biology.pdf
9. Monroe, M.B., O'Kuma, T.L. and Hein, W.; Norton, M.J. Ed. (2005). Chapter 3: Best Practices and Chapter 5: Project Findings. *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Best Practices of Physics Programs.* American Associate of Physics Teachers. https://www.aapt.org/programs/upload/spin-up-tyc-booklet.pdf
10. American Physical Society and the American Association of Physics Teachers. (2025). Supporting Research-Based Teaching in Your Department. *EP3: Effective Practices for Physics Programs*. https://ep3guide.org/guide/supporting-research-based-teaching-in-department/
11. Darling-Hammond, L., Hyler, M.E., Gardner, M. and Espinoza, D. (2017). *Effective Teacher Professional Development.* Learning Policy Institute, Palo Alto, CA (2017). https://files.eric.ed.gov/fulltext/ED606743.pdf
12. AAPT Committee on Laboratories. (2014). *AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum*. American Association of Physics Teachers. https://www.aapt.org/Resources/upload/LabGuidlinesDocument_EBendorsed_nov10.pdf
13. American Physical Society and the American Association of Physics Teachers. (2025). Instructional Laboratories and Experimental Skills. *EP3: Effective Practices for Physics Programs.* https://ep3guide.org/guide/instructional-laboratories-and-experimental-skills
14. Mason, A.J. and Singh, C. (2026). Andrew J. Mason and Chandralekha Singh. Impact of Guided Reflection with Peers on the Development of Effective Problem Solving Strategies and Physics Learning. *Phys. Teach.* 54, 295-299. https://doi.org/10.1119/1.4947159
15. Close, E.W., Conn, J. and Close, H.G. (2016). Becoming physics people: Development of integrated physics identity through the Learning Assistant experience. *Phys. Rev. Phys. Educ. Res.* 12, 010109. https://doi.org/10.1103/PhysRevPhysEducRes.12.010109
16. Cascarano, F. and Marasco, D. (2025). The Physics Show – A community college delivers BIG on community outreach. *The Physics Teacher*, 63, 704-705. https://doi.org/10.1119/5.0266558
17. American Physical Society and the American Association of Physics Teachers. (2025). Community Engagement and Outreach. *EP3: Effective Practices for Physics Programs.* *https://ep3guide.org/guide/community-engagement-outreach/*
18. American Physical Society and the American Association of Physics Teachers. (2025). Departmental Culture and Climate. *EP3: Effective Practices for Physics Programs.* *https://ep3guide.org/guide/departmental-culture-and-climate/*
19. Bennett, M., Hinko, K. and Izadi, D. (2021). It's Time to Act on Supporting Public Engagement. *Physics* 14, 102. DOI: 10.1103/Physics.14.102

20. Stanley, B., Izadi, D., Fracchiolla, C. and Hinko, K. (2023). Central role of personnel in informal physics programming. *Phys. Rev. Phys. Educ. Res.* 19, 020115. https://doi.org/10.1103/PhysRevPhysEducRes.19.020115

Appendix A: History and Mission of the Community College

1. Wright-Kim, J. (2022). An update on the impacts of the community college baccalaureate. In C. Cutler White (Ed.), *Advocacy for changes: Positioning community colleges for the next 75 years. New Dir for Community Coll. 197,* 59-70. John Wiley and Sons, Inc. https://doi.org/10.1002/cc.20497
2. U.S. Department of Education. (2026). *Community College Facts at a Glance. https://www.ed.gov/higher-education/find-college-or-educational-program/community-college/community-college-facts-glance*
3. Cohen, A.M. and Brawer, F.B. (1996) *The American Community College, 3rd ed.* Jossey-Bass, Inc. San Francisco, CA.
4. Community College Research Center. (2025). *An Introduction to Community Colleges and Their Students.* Teachers College, Columbia University, New York, New York. https://ccrc.tc.columbia.edu/publications/an-introduction-to-community-colleges-and-their-students.html
5. Pedersen, R.P. (2000). *The Origins and Development of the Early Public Junior College: 1900-1940.* Doctoral Dissertation, Columbia University, New York, New York. https://files.eric.ed.gov/fulltext/ED457915.pdf
6. U.S. Senate (1862). *The Civil War: The Senate's Story; The Morrill Land Grant College Act.* https://www.senate.gov/artandhistory/history/common/civil_war/MorrillLandGrantCollegeAct_FeaturedDoc.htm
7. U.S. Code. (1890). *Title 7, Chapter 13, Subchapter II, § 323. https://www.law.cornell.edu/uscode/text/7/323*
8. Drury, R.L. (2003). Community Colleges in America: A Historical Perspective. *Inquiry, 8 (1).* Virginia Community College System. https://files.eric.ed.gov/fulltext/EJ876835.pdf
9. Vaughan, G.B. (1985). *The Community College in America: A Short History, Revised.* American Association of Community and Junior Colleges, National Center for Higher Education, Washington, DC. https://files.eric.ed.gov/fulltext/ED255267.pdf
10. McDowell, F.M. (1919). *The Junior College.* Department of the Interior, Bureau of Education, Bulletin No. 35. https://files.eric.ed.gov/fulltext/ED541201.pdf
11. Ricketts, G. (2009). Community Colleges: A Brief History. National Association of Scholars. https://www.nas.org/blogs/article/community_colleges_a_brief_history/
12. Lange, A.F. (1915) The Junior College. *Journal and Proceedings of Fifty-Third Annual Meeting and International Congress on Education,* 119-124. National Education Association, Ann Arbor, MI. https://babel.hathitrust.org/cgi/pt?id=uc1.b3433948&seq=7
13. Brint, S. and Karabel, J. (1989). *The Diverted Dream: Community Colleges and the Promise of Educational Opportunity in America, 1900-1985, Part I.* Oxford University Press, New York, New York.
14. Zook, G.F., Blanding, S.G., McConnell, T.R., et al. (1947). Chapter II: Education for All. *Higher Education for American Democracy: A Report of the President's Commission on Higher Education, Vol. 1.* U.S. Government Printing Office, Washington, DC. *https://play.google.com/books/reader?id=wvCcAAAAMAAJ&pg=GBS.PR1&hl=en*
15. Weigner, P.R. (1999). Maintaining a Historical Perspective. *Community College Week,* Autumn Publishing Enterprises, Inc. Accessed through Academic Search Ultimate. https://research-ebsco-com.proxy-um.researchport.umd.edu/c/jbv2fl/viewer/html/q2lbbodxp5

16. Kasper, H.T. (2002). The changing role of community college. *Occupational Outlook Quarterly,* 14 (4),*14-21.* Accessed through Academic Search Ultimate. https://research-ebsco-com.proxy-um.researchport.umd.edu/c/jbv2fl/viewer/pdf/lyexzsssrj
17. Wissehr, C., Barrow, L.H. and Concannon, J. (2111). Looking Back at the Sputnik Era and Its Impact on Science Education. *School Science and Mathematics,* 3 (7), 368-375. Accessed through Academic Search Ultimate. https://research-ebsco-com.proxy-um.researchport.umd.edu/c/jbv2fl/viewer/pdf/sbzybkn6fz
18. American Association of Physics Teachers (UD) *History of AAPT – Commission on College Physics.* https://www.aapt.org/aboutaapt/history/ccp.cfm
19. American Association of Physics Teachers. (UD) *History of AAPT – Two-Year College Physics.* https://aapt.org/aboutaapt/history/TYC-Physics.cfm
20. Lui, K.P.H., O'Kuma, T. and Hilborn, R. (2021). Linking physics in two-year colleges and physics professional societies. *New Directions for Community Coll.* 2021, 1113-124. https://doi.org/10.1002/cc.20457
21. Velasco, T., Fink, J., Bedoya, M., Davis, J. and LaViolet, T. (2024). *Tracking Transfer: Community College Effectiveness in Broadening Bachelor's Degree Attainment.* Community College Research Center, Teacher's College, Columbia University, New York, New York. https://ccrc.tc.columbia.edu/wp-content/uploads/2024/02/Tracking-Transfer-CC-REvised-2025.pdf
22. National Student Clearinghouse Research Center. (2026). *Final Fall Enrollment Trends.* https://nscresearchcenter.org/final-fall-enrollment-trends/
23. Townsend, B.K. (2009). The Outlook for Transfer Programs and the Direction of the Community College. In *New Directions for Community Colleges,* 146, 103-110. Accessed through Academic Search Ultimate. https://research-ebsco-com.proxy-um.researchport.umd.edu/c/jbv2fl/viewer/pdf/w2z7wabcpv
24. Meza, E. and Love, I. (2023). When Community Colleges Offer a Bachelor's Degree. *New America,* Mar. 28, 2023, Washington, DC. https://www.newamerica.org/insights/when-community-colleges-offer-a-bachelors-degree/
25. Community College Research Center. (2025). *Community College Transfer.* Teachers College, Columbia University, New York, New York. https://ccrc.tc.columbia.edu/wp-content/uploads/2025/12/CC-Transfer-Fact-Sheet.pdf