EDUCATOR'S PRACTICE GUIDE SUMMARY

USING TECHNOLOGY TO SUPPORT POSTSECONDARY STUDENT LEARNING

A Practice Guide for College and University Administrators, Advisors, and Faculty

Many colleges are exploring ways to leverage technology to improve student retention and increase the educational options for and success of their diverse student bodies. Technology is infused in almost every aspect of college life. Colleges are using technology to improve the quality of student learning; make active and engaging learning available throughout institutional offerings; and help students become more successful learners. This *Using Technology to Support Postsecondary Student Learning* practice guide, developed by the What Works Clearinghouse™ (WWC) in conjunction with an expert panel, focuses on promising uses of technologies associated with improving postsecondary student learning outcomes.

This summary introduces the recommendations and supporting evidence described in the full practice guide. These recommendations will help higher education instructors, instructional designers, and administrators support learning through the effective use of technology. For a full description of the recommendations and more implementation tips, **download your free copy of the guide**.

RECOMMENDATIONS IN THIS PRACTICE GUIDE

1. Use communication and collaboration tools to increase interaction among students and between students and instructors.
2. Use varied, personalized, and readily available digital resources to design and deliver instructional content.
3. Incorporate technology that models and fosters self-regulated learning strategies.
4. Use technology to provide timely and targeted feedback on student performance.
5. Use simulation technologies that help students engage in complex problem-solving.

Recommendation 1: Use communication and collaboration tools to increase interaction among students and between students and instructors.

When used effectively, communication and collaboration tools can increase engagement by allowing students to communicate about course content and their learning experiences. The relationships that college students form with their instructors and with one another enable them to create connections around common learning goals, build knowledge and identity, and develop a sense of belonging.[1] These relationships and interactions are believed to foster student engagement and belonging, which may influence postsecondary students' performance and persistence.[2] Instructors and administrators in postsecondary settings can facilitate communication and collaboration among students and between students and instructors through the use of technology both inside and outside the classroom, whether those classrooms are traditional, blended, or exclusively online.

How to Carry Out the Recommendation

1. Select communication and collaboration tools that will best support learning objectives.

When selecting technologies to support communication and collaboration, instructors should consider which tools are best suited to help students meet the objectives for the course or for individual activities within the course. Among several types of technologies to choose from, instructors might find it helpful to use one or more tools that support asynchronous communication, synchronous communication, or social networking.[3] Instructors should ensure that the use of these tools is not distracting students from their learning goals. They should also check whether any institutional policies restrict the use of social networking tools in the classroom.

2. Consider student preferences and levels of access when adopting new technology.

Instructors should consider student preferences and experience when selecting tools to adopt in their courses. Key considerations to keep in mind include:

- Students in general are frequent users of mobile phones, tablets, and laptops, but different groups of students might have different preferences and varying degrees of access to these devices.
- Some students might prefer social media technologies such as Twitter to institutional learning management system technologies because they are more familiar with social media technologies.
- Other students might be apprehensive about mixing their personal and academic lives online.

At the beginning of the semester, instructors can survey students on their use of technologies. Survey responses can help the instructor to incorporate the tools students are already using or to plan time for students to get used to any unfamiliar technologies selected for the course.

3. Articulate expectations for when and how students should use communication and collaboration tools, both inside and outside the classroom.

When introducing communication and collaboration tools—even those familiar to students—instructors must be clear about the purpose of using these tools within their course. Students will benefit from clear expectations about when and how they should use those spaces. When use of these tools factor into instructors' assessments of student performance,

grading criteria and rubrics should be shared with students at the beginning of the course. Instructors should also provide guidelines for interacting respectfully and protecting privacy in communication and collaboration spaces.

4. **Seek information about communication and collaboration technologies currently available on campus, and determine whether there is guidance and support for using them.**

   Instructors should check with other instructors and staff at their institution for existing resources, such as teaching and learning centers. Instructors can ask instructional designers about the availability of technologies that support communication and collaboration, as well as which are most popular among students and other instructors.

5. **Monitor student participation, and provide facilitation and feedback as needed.**

   Communication and collaboration tools that enable discussion forums and blogging can be used to provide students the opportunity to write reflectively, discuss learning experiences, and react to the experiences of classmates. Instructors can model desired behaviors; then if students are not engaging or contributing as expected, instructors can redirect them or provide additional support. Instructors should encourage contributions from all students and discourage negative exchanges, such as bullying or unhelpful criticism, when they occur. In the online course setting, instructors must be diligent in monitoring communication boards and following up with students.

6. **Assess what is working (and what is not).**

   Instructors should assess whether the selected communication and collaboration tools are effectively supporting interaction among students and between students and instructors. Answers to the following questions give insight on the quantity and quality of interactions:

   - Who participates in the conversations, and are there any distinguishing characteristics between those who do and do not participate?
   - Is the instructor able to respond to students in a timely fashion?
   - Are students engaging in meaningful conversation on the communication boards?
   - Is teamwork improving; for example, as gauged by the quality of group work and projects?

ENGAGING STUDENTS THROUGH MICROBLOGGING

Instructors of a first-year seminar course for pre-health professional majors used Twitter in an effort to improve the engagement and achievement of their students (Junco, Heiberger, & Loken, 2011). Twitter can be thought of as a microblogging tool that also serves as a social network. At the beginning of the semester, the instructors provided an hour-long training on how to Tweet. The platform helped them increase student engagement throughout the semester by:

- Providing students with a venue for continuing conversation started in class by making and replying to Twitter posts;
- Enabling instructors to post information for students about campus resources and events, such as tutoring services, speakers, and volunteer activities;
- Providing alternatives to posing questions to the instructors by allowing students to submit questions outside of class via Twitter posts;
- Encouraging students to schedule and coordinate activities and study sessions with peers; and
- Providing students opportunities to practice using the communication tool as a way to complete Twitter-based assignments and tasks such as posting questions and reactions related to course content. For example, students were given an optional assignment of attending an upper-class student panel and Tweeting questions for the panelists.

SUMMARY OF EVIDENCE FOR RECOMMENDATION 1

WWC staff and the expert panel assigned a **minimal** level of evidence based on three studies of the effectiveness of communication tools designed to foster collaboration and build community. The three studies involved direct tests of the recommendation, were conducted in college course settings, and involved a large number of students across nine postsecondary institutions. However, only one of the three studies meets WWC standards.

WWC Evidence Ratings: One of the studies meets WWC group design standards without reservations, and the two other studies do not meet WWC group design standards.

Outcomes: Academic achievement was assessed in two of the three studies; both studies reported statistically significant positive impacts on persistence in favor of the intervention groups. Persistence was assessed in two of the three studies; both studies reported statistically significant positive impacts in favor of the intervention groups. Student engagement was reported in one study, which reported statistically significant positive impacts in favor of the intervention groups.

For more information: See the description of evidence for Recommendation 1 on pages 65-67 of the practice guide.

Recommendation 2: Use varied, personalized, and readily available digital resources to design and deliver instructional content.

With instructor support and appropriate pedagogy, technology can help create productive educational experiences for larger numbers of students and a more diverse student population.[4] The panel recommends that institutions of higher education leverage technology to help students learn more productively by: (a) varying, blending, or accelerating course formats; and (b) packaging course content to minimize cost, maximize accessibility, and accommodate different learning preferences.

Administrators can encourage instructors and instructional designers to use technology to create blended or flipped courses, in which some lecture material and other course content are delivered online. These formats may preserve more class time for hands-on and other experiential activities, group assignments, and individualized instruction, rather than for lecture. Technology can be used to package content in multiple ways that help students access and study course materials. This is especially true when the interface is interactive, flexible, and offers multiple ways and times for students to access the content.

How to Carry Out the Recommendation

1. **Leverage technology to vary the format for delivering courses.**

   A variety of options exist to structure a course in ways that differ from traditional classroom instruction. Instructional designers can collaborate with instructors to help them select course delivery structures that are appropriate for the content of the course and the students taking the course. They also can help instructors plan and implement blended and flipped course formats. Further, they can guide instructors in their selection of online course activities, including interactive modules that provide students feedback as they navigate the lesson content.

2. **Plan instruction so that course content is carefully packaged and sequenced, and use technology to scaffold students' acquisition and application of the content.**

   Instructors who wish to adopt blended or flipped course formats should ensure the course content is suitably matched to the selected course structure and delivery modalities. In doing so, instructors decide which content will be covered in online modules, in class, or in both learning environments. Instructors must also consider their method(s) for delivering content. Instructors can accommodate students' varied learning preferences by offering multiple pathways to learning the same material. One way to do this is to package content in more than one format.

   With support from their colleagues or instructional designers, instructors should aim to incorporate multiple media formats throughout the duration of a course. By presenting material in multiple ways, instructors may help students develop mental representations, reduce their cognitive load, and test their understanding of content. Students' understanding of course material may be deepened through engaging in interactive online modules or by viewing simulations or visualizing content in new ways. Technology such as podcasts, instructional videos, and other online media may be used to maximize efficiencies in students' review of course material and homework. Students can also use technologies to demonstrate their understanding and apply their knowledge.

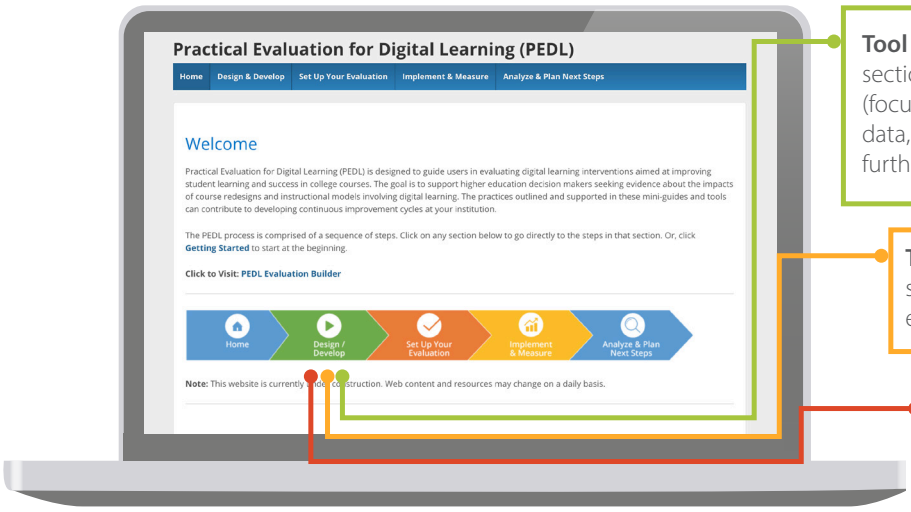
3. When varying course formats or course packaging, instructors should clearly communicate expectations for what students should do during the course.

In addition to describing a course's goals and objectives, instructors must explain its format and modes for delivering its content. They also should describe their expectations for what students need to be prepared to do before, during, and after class sessions. Instructors might plan to primarily follow a traditional face-to-face format but also incorporate various technologies to deliver or review course content. They should demonstrate to students how they are expected to use those technologies to support their learning or complete assignments.

4. Monitor and evaluate the effectiveness of course formats and use of multimedia to deliver content.

Instructors, department heads, and administrators share responsibility in monitoring and evaluating the effectiveness of the course formats and delivery modes used to engage and teach learners. Together, they can determine which instructional approaches should be continued—or discontinued—with future student cohorts.

SAMPLE TOOLKIT FOR EVALUATING DIGITAL LEARNING INTERVENTIONS: PRACTICAL EVALUATION FOR DIGITAL LEARNING (PEDL)



Tool 3a: Evaluating Small Course/Single Course section if you are already using the technology (focuses mainly on identifying needs, obtaining data, collecting qualitative feedback, and assessing further information needs).

Tool 6: Checklist of Roles (describes types of staff members on campus who can help with each part of the study).

Tool 5: Study Design Options (choosing the right options based on the decision that needs to be made; brief overview of RCT, QED, and descriptive study designs).

SOURCE: http://evaltoolkit.wpengine.com/ **Username:** demo **Password:** evaluation

SUMMARY OF EVIDENCE FOR RECOMMENDATION 2

WWC staff and the expert panel assigned a **moderate** level of evidence based on 16 studies of the effectiveness of varied, personalized, and readily available digital resources that design and deliver instructional content. The supporting studies all provide a direct test of the recommendation and have strong internal and external validity. The preponderance of evidence shows positive effects; however, one study did show negative effects on academic achievement outcomes.

WWC Evidence Ratings: Eleven studies meet WWC group design standards without reservations. Five studies meet WWC group design standards with reservations.

Outcomes: Academic achievement was assessed in each of the 16 studies. Six studies found positive effects on outcomes in the academic achievement domain, nine studies found indeterminate effects in this domain, and one study found negative effects. One of the studies that found indeterminate effects on academic achievement also found positive effects on credit accumulation and persistence.

For more information: See the description of evidence for Recommendation 2 on pages 68-77 of the practice guide.

Recommendation 3: Incorporate technology that models and fosters self-regulated learning strategies.

Effective learning depends on knowing how to learn and to manage one's own learning processes. Some students gain these skills prior to enrolling in college, but many do not. Those who do not often struggle once in college, where instructor supervision can be minimal and students have considerable autonomy in their educational activities. They may lack awareness and understanding of their own learning processes and struggle to self-direct their learning activities. Online and blended learning environments can magnify these challenges because they can require extra levels of self-direction, organization, and planning from the student.[5,6] The panel recommends using technologies that facilitate the incorporation of self-regulated learning into all learning environments, including face-to-face, blended, and online course delivery formats, as a way to help students successfully self-direct their engagement with course content and learn more effectively.[7]

How to Carry Out the Recommendation

1. **Select tools and technologies that serve as scaffolds to help students apply self-regulated learning strategies.**

   Instructors should consider what they want students to accomplish with regard to self-regulated learning—either throughout a course or during a specific lesson or unit—and select tools to help students acquire and apply self-regulated learning strategies. Self-monitoring prompts embedded in online activities boost students' comprehension by activating prior knowledge and encouraging them to organize their thinking while learning. Other tools to encourage self-regulated learning include content creation and delivery tools; communication and collaboration tools; and administrative tools such as calendars and web-based to-do lists. Email and text-based "nudge" messages, assessment tools that monitor student progress and generate alerts or messages to instructors and/or students, and software-based student-support systems that can send personalized messages are further examples of technologies that support self-regulated learning.

SAMPLE TRAINING MODEL TO SUPPORT SELF-REGULATION THROUGH LEARNING TECHNOLOGIES

The instructor identifies the learning task; determines the processes, steps, or procedures associated with performing the learning task; and then uses the following four-phase training model:

PHASE 1: OBSERVATION
Enables students to think strategically before acting

PHASE 2: EMULATION
Enables students to gather information about their learning behaviors and performance with the help of the instructor and peers

PHASE 3: SELF-CONTROL
Enables students to focus on mastering the steps related to completing the learning task during practice episodes

PHASE 4: SELF-REGULATION
Enables students to focus on outcomes and make strategic adjustments when performing poorly

SOURCE: Adapted from Kitsantas et al. (2015), p. 286

2. **Model how to use self-regulated learning strategies, and provide students with opportunities to practice self-regulated learning strategies using technology.**

   Students may need instruction on self-regulated learning strategies, including what they are, why they are important, and how to use them. Campus resource centers should offer students training, videos, and other resources on self-regulated learning strategies. Instructors and advisors should also become well versed in these resources so they can encourage students to access, learn, and apply self-regulated learning strategies. Instructors should model the use of self-regulated learning strategies. Students need opportunities to practice self-regulated learning strategies before they can get into the habit of applying them.

3. **Select technologies that feature tutoring or mentoring components to support students in using self-regulated learning strategies.**

   Tutors can serve as a scaffold by providing supports and helping students enact various aspects of self-regulated learning. Emerging technologies, such as intelligent tutoring systems, cognitive tutors, and adaptive learning environments, can offer promising alternatives to face-to-face adaptive tutoring, which can be resource intensive. Pedagogical agents can be embedded in computer-based learning environments to complement and extend other scaffolds such as searchable text, simulations, and concept maps.

4. **Assess whether the selected technologies are effectively supporting students in their use of self-regulated learning strategies.**

   Most online environments, including course and learning management systems, track students' time spent in various activities or functions. To the extent possible, instructors should monitor which functions and features students are using most frequently. Instructors should poll students to determine whether the technologies, such as note-taking features, self-monitoring prompts, and feedback features, are helping them apply specific self-regulated learning strategies. Instructors can also examine usage data and student performance to see if there is any association between the two.

SUMMARY OF EVIDENCE FOR RECOMMENDATION 3

WWC staff and the expert panel assigned a **moderate** level of evidence based on four studies that examined the effectiveness of various strategies to foster or activate student self-regulation. The strong internal validity of the four studies, the largely consistent effects on student academic achievement, and the range of self-regulation-promoting technologies tested all point to the benefits and broad applicability of the technologies and interventions tested.

WWC Evidence Ratings: All four studies meet WWC group design standards without reservations.

Outcomes: Academic achievement was assessed in each of the four studies. On academic achievement outcomes: one of the studies reported statistically significant positive effects, two of the studies reported a mix of statistically significant positive and indeterminate effects, and one study reported indeterminate effects. The study that reported indeterminate effects on academic achievement outcomes also reported indeterminate effects on credit accumulation and persistence outcomes.

For more information: See the description of evidence for Recommendation 3 on pages 78-81 of the practice guide.

Recommendation 4: Use technology to provide timely and targeted feedback on student performance.

Technology permits rapid assessment and tabulation of student responses and can be used both in and outside of class. Thus, technology provides opportunities for students to engage with content and demonstrate their understanding, or lack of understanding, to themselves and to their instructor at the time that learning activities occur. Technology that facilitates assessment and the provision of timely feedback, whether in or outside of class, with individual students or with groups, also provides data that can be used to tailor and modify instruction to better address students' learning needs and challenges. Among the most widely used technologies in traditional face-to-face courses for providing immediate feedback are automated student response systems. These can be hand-held devices or polling applications for smartphones or tablets/laptops that allow students to respond to questions. Outside of class time, or in blended and online courses, timely feedback can be provided via online assessments, assignments, or polling applications. Feedback systems can also be incorporated into online courses and modules by using embedded assessments.

How to Carry Out the Recommendation

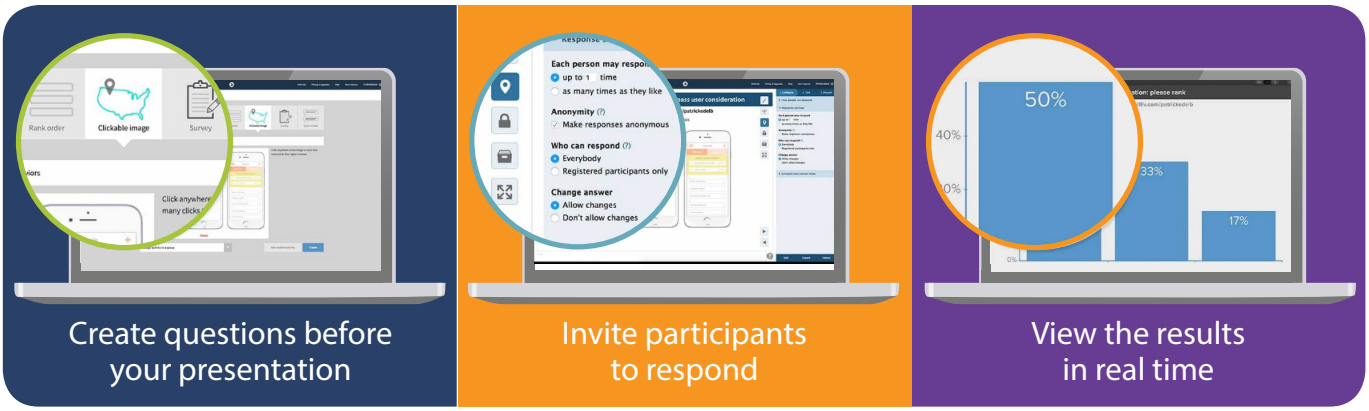
1. **Determine the course segments or content for which students would benefit most from timely and targeted feedback.**

   Students and instructors benefit from timely feedback about performance related to concepts that are commonly misunderstood by students.[8] Exams and homework from previous terms can be mined to identify such concepts. Class discussions and student questions can also help identify the nature of common student misunderstandings. Armed with this information, instructors can then select the concepts to cover and plan the timing of assessment, such as polling in class or giving quizzes prior to class meetings. They also can plan the type and format of feedback (group or individual) best suited to helping students understand their mistakes or understand difficult concepts.

2. **Decide which technologies to use for providing feedback.**

   After deciding to use technology to check students' understanding and provide timely, targeted feedback, instructors must select the tools that best align with their course format and the content about which feedback will be provided. Face-to-face learning environments can incorporate technology-based questioning and real-time tabulation of data from the entire class. In online courses, especially those that are delivered asynchronously, it might be more feasible to provide immediate feedback to students through automated scoring of online homework or quizzes. Online learning environments can be designed to provide students immediate feedback on navigational choices and on answers they provide to questions posed throughout a lesson, in online homework, or in quizzes. Many of the adaptive learning environments have built-in assessments and can provide timely feedback.

SAMPLE CLASSROOM POLLING TOOL: POLL EVERYWHERE



SOURCE: https://www.polleverywhere.com/how-it-works

3. Strategically incorporate feedback technologies into the course.

Instructors must make decisions about how to incorporate feedback into their lectures and course units. The physical organization, features, and amenities of the classroom, such as seating arrangements and availability of wireless internet, for example, might influence choices about which technologies can be used for in-class assessment and feedback. At the same time, class size and class duration should be considered when planning how to incorporate technology-based feedback into a face-to-face course, as these factors can influence how much time the instructor dedicates to discussion of student responses. In all types of course formats, technologies should be selected to provide feedback that aligns with course objectives and goals.

4. Design questions that align with the desired learning objectives.

Instructors must construct the questions they will ask in class with student response systems, include on online homework assignments, or use in online assessments. Before drafting questions, instructors should identify learning objectives for the activity or unit that will include feedback. The optimal difficulty level of questions can vary for different groups of students, and instructors should pilot and refine questions. Instructional designers and teaching and learning center staff can help instructors write questions at the higher levels of Bloom's Taxonomy in order to extend their assessment beyond knowledge-level multiple-choice questions.[9]

5. Use data to inform instruction, and to help students guide their learning.

Instructors collecting real-time data about students' understanding during a face-to-face class or in a synchronous online session can implement audience-paced instruction. Such instruction means the instructor can decide whether to continue a lecture/discussion or pause to elaborate on concepts students are not yet mastering. Instructors can use webpages or chat functions that allow students to anonymously post questions and comments during a class. Then the instructor can periodically pause to check for questions and comments and address any without individual students feeling on the spot for raising the question or comment. Data gathered through online assessments conducted during lessons, especially if tabulated quickly for the instructor, can highlight concepts the instructor should review with students before moving to the next lesson or unit in the course. When providing timely and targeted feedback to students, instructors also can provide guidance on how students can use data to improve their future performance.

6. Work collaboratively to adopt and integrate newer technologies.

Sophisticated technologies are being developed to provide students with feedback that supports metacognitive thinking and reflection when they are online, such as adaptive learning environments, interactive online modules and courses, and intelligent tutoring systems. Instructors, instructional designers, and software developers can collaborate to develop and adopt these technologies.

SUMMARY OF EVIDENCE FOR RECOMMENDATION 4

WWC staff and the expert panel assigned a **moderate** level of evidence based on eight studies that examine the use of technology to provide timely and targeted feedback on student performance. The supporting studies have strong internal and external validity, examine a range of feedback technologies, and have largely consistent effects on student academic achievement.

Strength of Evidence: Five studies meet WWC group design standards without reservations. Two studies meet WWC group design standards with reservations. One study that tested multiple interventions reported on comparisons that meet group design standards without reservations and comparisons that meet group design standards with reservations.

Outcomes: The eight studies examine the effectiveness of ten interventions on academic achievement outcomes. Five interventions were shown to have statistically significant positive effects and five were shown to have indeterminate effects in this domain. One of the interventions shown to have indeterminate effects on academic achievement had positive effects on credit accumulation and persistence.

For more information: See the description of evidence for Recommendation 4 on pages 82-86 of the practice guide.

Recommendation 5: Use simulation technologies that help students engage in complex problem-solving.

Incorporating complex problem-solving activities into postsecondary instruction allows students to interact more deeply with learning material, to practice higher-order thinking skills, and to make connections among concepts. These activities can promote engagement, which enhances student understanding and improves retention of material.[10] As technology has evolved, new options that provide realistic and immersive problem situations, support testing and analysis of multiple scenarios, and involve social interactions among students have emerged. These are promising strategies for engaging students in complex problem-solving. Technologies that simulate complex problems might include one or more of the following features: allow learners to make decisions and observe the outcomes of their decisions, provide an opportunity for students to practice newly acquired skills, facilitate problem-based learning, and allow for immersive role playing.

How to Carry Out the Recommendation

1. **Assess and decide whether a course offers the appropriate context for using technologies that simulate complex problems to promote higher-order thinking and problem-solving skills.**

   Not all courses are suited for including complex simulations or problem-based learning activities. Instructors and instructional designers should consider whether the curriculum and content of the course can give students the time to engage with authentic, complex problems or the focus instead is on mastery of introductory core concepts. In planning and implementing successful simulated learning experiences, instructor and student preparation are important, as is including time for post-experience discussion and reflection.

2. **Establish the learning objectives first, and then select an activity with the right level of complexity.**

   Instructors and instructional designers should first determine the goals they hope to achieve through technologies that simulate complex problems, and then select an activity or case that can help to accomplish those goals. Instructors should consider whether they want students to work independently or in small groups, and then identify technologies that have been successfully used by other instructors in that setting. They should select a technology that has the appropriate amount of complexity to achieve the learning objective or one that increases in complexity as learners achieve deeper understanding of the material.

3. **Introduce students to expectations for the simulated learning activity, and provide supports to ensure they feel comfortable in the learning environment.**

   Instructors should be clear and transparent about the outcomes students are expected to achieve through the simulated learning activity. Instructors also should explain that team-based learning focused on solving a complex problem is an opportunity for students to develop collaborative decision-making skills. Before allowing students to begin simulation learning activities, instructors should make sure the technology is working and there are no other barriers to navigating it. This includes explaining how to use the technology and where students can get help should technology-related questions arise.

SAMPLE TIPS FOR GROUP PROBLEM-BASED LEARNING ASSIGNMENTS USING IMMERSIVE TECHNOLOGY

1. Convey the expectation that students work collaboratively to solve or manage the problem.
2. If students are collaborating online, encourage the use of synchronous collaboration tools such as group chat, shared whiteboards, video conferencing, and group browsing.
3. Make the learning objectives of the assignment readily accessible to the students.
4. Give students the ability to negotiate their own learning needs in the context of the assignment.
5. If possible, assign tutors to work directly with the teams to provide support and facilitate discussion (but not to direct discussion). This tutor can also plan real-time collaboration sessions using the synchronous tools mentioned previously.

SOURCE: Savin-Baden et al., (2011)

4. Lead students in reflective discussion to help them evaluate their own learning.

Instructors should help students to understand there might not be a "right" answer to simulated problems presented in activities, especially because students bring diverse perspectives to situations. Students should be encouraged to be comfortable with ambiguity and failure and should be guided to reflect on and learn from their mistakes. Instructors should encourage collaboration so that students take advantage of the opportunity to learn from the experiences of peers engaging with the same complex problem.

5. Keep an eye out for new or evolving technologies that support effective, engaging complex problem-solving.

Emerging immersive, virtual world, augmented- and mixed-reality, and artificial intelligence technologies all offer exciting learning opportunities for students to work together on complex problems that simulate real-world scenarios. Evidence on the impacts of these emerging technologies on learning is scant thus far. Educators should keep an eye out for information on how these cutting-edge technologies can be applied to foster learning in face-to-face, online, or blended courses.

SUMMARY OF EVIDENCE FOR RECOMMENDATION 5

WWC staff and the expert panel assigned a **minimal** level of evidence based on two studies that examined the effects of a web-based simulated problem-based learning experience. The minimal evidence rating assigned to this recommendation is due to the limited research evidence that meets WWC standards and the low level of external validity of that evidence.

Strength of Evidence: One study meets WWC group design standards without reservations and one study meets WWC group design standards with reservations.

Outcomes: The two studies used as evidence to support this recommendation found statistically significant positive effects on measures of academic achievement.

For more information: See the description of evidence for Recommendation 5 on pages 87-88 of the practice guide.

Endnotes

[1] Garrison, Anderson, & Archer (2010); Visher, Wathington, Richburg-Hayes, & Schneider (2008).

[2] Kuh et al. (2008); Lillis (2011); Umbach & Wawrzynski (2005).

[3] Asynchronous communication is time-independent and allows participants to communication without needing to be present at the same time, while synchronous communication supports interaction in real or same time, and requires all participants to be present at the same time, either face-to-face or virtually.

[4] For an integrated multimodal model for online education, see Picciano (2017).

[5] Azevedo, Cromley, & Seibert (2004).

[6] Some web-based technologies lack the supports students have traditionally relied on to help them organize and process learning content. For example, online materials sometimes lack page numbers to let learners know how far along they are in their reading.

[7] Pintrich (2000); Zimmerman (1990, 2000).

[8] Bruff (2009).

[9] See Anderson & Krathwohl (2001).

[10] Driscoll (2000); Johnson, Johnson, & Smith (1998); Savery & Duffy (1995).

For more practical tips and useful classroom examples, download a copy of the *Using Technology to Support Postsecondary Student Learning* practice guide at **https://ies.ed.gov/ncee/wwc/PracticeGuide/25**.

The Institute for Education Sciences publishes practice guides in education to provide educators with the best available evidence and expertise on current challenges in education. The WWC develops practice guides in conjunction with an expert panel, combining the panel's expertise with the findings of existing rigorous research to produce specific recommendations for addressing these challenges. The expert panel for this guide included Nada Dabbagh, Randall Bass, MJ Bishop, Anthony G. Picciano, and Jennifer Sparrow. See Appendix A on p. 56 for a full description of practice guides.

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