
Inclusive Instruction With Adaptive Courseware



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About the Supporting Organizations



Every Learner Everywhere is a network of twelve partner organizations with expertise in evaluating, implementing, scaling, and measuring the efficacy of education technologies, curriculum and course design strategies, teaching practices, and support services that personalize instruction for students in blended and online learning environments. Our mission is to help institutions use new technology to innovate teaching and learning, with the ultimate goal of improving learning outcomes for Black, Latinx, and Indigenous students, poverty-affected students, and first-generation students. Our collaborative work aims to advance equity in higher education centers on the transformation of postsecondary teaching and learning. We build capacity in colleges and universities to improve student outcomes with digital learning through direct technical assistance, timely resources and toolkits, and ongoing analysis of institution practices and market trends. For more information about Every Learner Everywhere and its collaborative approach to equitize higher education through digital learning, visit www.everylearnereverywhere.org.



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Part I: The State of Accessibility and Inclusion within Adaptive Courseware

Higher-education institutions have a moral and legal responsibility to ensure that the learning tools employed in the classroom are equally accessible by all students. This brief provides an overview of the approaches that institutions and vendors use to improve the inclusivity of courseware products.

Questions addressed

- What are the most important things to consider when trying to develop accessible and inclusive courseware?
- What is the role of representatives at various levels of educational institutions as well as that of vendors to ensure courseware is accessible and inclusive?
- What does it mean to make courseware accessible?

Key Insights

There is a lack of consensus surrounding the most effective methods for improving the accessibility and inclusivity of adaptive courseware.

It is the collective responsibility of institutions and vendors to ensure that their courseware products are accessible by all students.

Accessibility extends far beyond students' ability level to include other demographic information such as race, gender, cultural background, geographic location of inhabitants, and socioeconomic status.

Introduction

The research focus on inclusion and access to adaptive courseware in higher education peaked in the early 2000s, in tandem with the rising interest in the use of courseware itself. At that time, there was a strong push for the development of accessibility standards that could be applied to the creation and application of higher education courseware. It was believed that the strongest catalyst for the widespread adoption of accessible adaptive courseware would be legally requiring institutions to do so (Rowland, 2002). To supplement the policy updates that came later in the decade, a mixture of primary research efforts and thought leadership in the field yielded a succession of recommendations for how to create accessible courseware that catered to the needs of students with disabilities as well as those with cost, technological, and other barriers to access.

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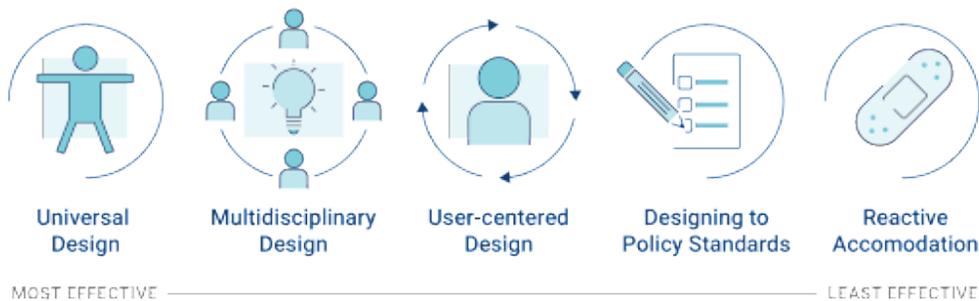
It is possible that the combination of legal mandates and the supposed saturation of the topic from a research perspective caused the subsequent decline in the broad-scale attention paid to courseware accessibility (Shurr, 2013). Unfortunately, the majority of institutions and vendors today still feel little responsibility to ensure their courseware products are accessible; an industry-wide view of the United States education system reveals that there may be as high as 87% of academic institutions who fail to meet legal requirements for accessibility (ADA, 2015). [Current laws](#) only require the provision of reasonable accommodations, a vague obligation to find makeshift solutions for students facing accessibility challenges. Furthermore, it seems that the small minority of stakeholders who have opted to prioritize the issue have little direction on where to start. As such, there is a lack of cohesion in the methods used to ensure a piece of courseware is accessible.

The downstream effects of this lack of cohesion are felt by institutions and vendors alike. Today, there are several approaches that institutions are employing in an effort to design more accessible courseware: (a) **universal design**, (b) **multidisciplinary design**, (c) **user-centered design**, (d) **designing to policy standards**, and (e) **reactive accommodation**. Likewise, there are a handful of methods that vendors use to evaluate whether their courseware is accessible: (1) **media type**, (2) **interaction level**, and (3) **ability level**. To better visualize how these approaches relate to each other and understand the potential outcomes of using each of them, you can refer to our Framework of Accessibility Approaches. The remainder of this brief is dedicated to summarizing how each of these approaches is described in the literature available to date.

Approaches to designing inclusive and accessible courseware

At the institutional level, several observable approaches to designing inclusive and accessible courseware have emerged, but there is a lack of consensus as to which is most effective. As mentioned earlier, the approaches employed today include (a) **Universal Design**, (b) **multidisciplinary design**, (c) **user-centered design**, (d) **designing to policy standards**, and (e) **reactive accommodation**. These approaches are not mutually exclusive; in some cases, application of multiple methods may yield the most effective results. The popularity, effectiveness, required financial investment, required time investment, and necessary stakeholder involvement of each approach should be considered when deciding what combination will best suit your institution's situation. Therefore, we designed our **Approach Selection Matrix** to serve as an aid for higher education institutions trying to identify which approach may be best for them. The following subsections provide a basic description of each approach, in order from most effective to least effective.

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Universal Design

Universal Design, known as Design-For-All in Europe, is a method of courseware design that intentionally has a structure, layout, and pattern of navigation which can be used by all people without accommodation or modification (Steyeart, 2005; Burgstahler, 2014; Tosho, 2015). Included in the Universal Design framework is the requirement for each component to be perceivable, operable, understandable, and robust. In addition, all content must have multiple means of representation, action/expression, and engagement (Bond, 2015). The outputs of a Universal Design process inherently extend beyond ability levels to include racial and ethnic backgrounds, ages, native languages, and learning styles (Burgstahler, 2017). A proactive approach to inclusion and access, Universal Design aims to eliminate the need for individual accommodation (Distance, 2011).

More than 80% of courseware and other learning materials today do not feature a Universal Design (Tosho, 2016). Research shows that university faculty and administrators are wary that universally designed courseware may be slower and more expensive to develop and result in products that are visually unattractive, relatively low-tech, and generally of lower quality for the majority of users (Wentz, 2011). Early studies have supported some of these concerns. An experiment conducted by Savidis (2006) involved students testing a universally designed chess game on the computer. Perhaps unsurprisingly, able-bodied students were collectively disappointed by the lack of 3D graphics and visual effects.

The long-term adoption of Universal Design will increase usability of courseware for all students, which far outweighs any minor reductions in visual appeal (Tosho, 2014). Furthermore, research demonstrates that universally designed technology can benefit people without disabilities as well (Burgstahler, 2015). This becomes apparent in cases of situational constraint, where, for example, loud rooms, browser incompatibility, or having full hands are disadvantageous in a learning context nearly as much as hearing, vision, or mobility impairments. Overall, universally designed courseware means easier navigation and use due to its call for clear and simple language, text alternatives for images, text to speech systems, video captions, and multiple formats to accommodate a variety of learning styles.

Multidisciplinary design

Multidisciplinary design calls on several separate stakeholders to create different parts of the courseware experience. In most cases, this means separating out structure, content, learning approaches, development processes, pedagogical design, and technological design (Guglielman, 2010; Aziz, 2014). The primary advantage of the multidisciplinary design approach is that there are many stakeholders involved and held accountable for the final product. Access to technology and courseware is likely best when managed by a team of people, not just academic disability services

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providers (North, 2002). Since the quality of teaching and learning has come to be viewed as an institutional responsibility, many institutions are adopting the following practices (Hanover, 2011):

Strengthening the courseware development process by establishing a cross-disciplinary, committee-driven review of courses and curricula;

Developing a student-faculty-alumni advisory board to guide program evolution;

Ensuring quality content delivery by providing academic and technical advisers who can assist students throughout the duration of the program;

Reviewing and improving programs by including all relevant stakeholders including area businesses and professional associations in discussions about course and program content and design.

There are many stakeholders beyond the university faculty and staff members who should be included in accessible design conversations as well. These include courseware and software vendors, educational publishers, authoring tool developers and vendors, authors and content developers, educational institutions (including administrators), educators and instructors, administrative staff, and students who will become the end users of the courseware (IMS, 2004).

User-centered design

User-centered design involves a proactive assessment of the needs of all of the potential users of courseware and selecting specific accommodations based on those needs. In a study by Fichten (2009), researchers explored eLearning problems and solutions reported by 223 students with disabilities, 58 campus disability service providers, 28 professors, and 33 eLearning professionals from Canadian colleges and universities. Results show that over 83% of users encountered at least one problem with the eLearning platform being tested, including a lack of readability, incomprehensible graphics, and inadequate navigational elements. This study complements efforts to develop courseware that allows users to customize it for their needs. As such, there are several steps to work through during courseware development for institutions applying this approach:

1. Consider the ways in which students may have varying personal factors, cognitive styles, strategies, and personal/subject matter knowledge that influence the ways in which they interact with courseware (Brusilovsky, 2000).
2. Consider the various functional limitations that users may have when accessing courseware, regardless of the cause of the limitation. This includes memory challenges, weak problem-solving skills, short attention spans, reading and verbal comprehension, match comprehension, and visual comprehension (Utah, 2009).
3. Build in opportunities for users to toggle settings based on these academic challenges (Fichten, 2009).

Designing to policy standards

Designing to policy standards is the “bare minimum” approach to developing accessible courseware. In this approach, accessible design is executed only to the level required legally, which varies from country to country and generally leaves room for a number of accessibility challenges. In the United States, the Department of Health and Human Services (HHS) [Office for Civil Rights](#) (OCR) is responsible for ensuring that educational institutions comply with the requirements of all federal civil rights laws. The current policy indicates that higher education institutions are required to update their course design to increase accessibility, but only if doing so does not create an undue financial burden for the institution.

Generally, industries have reacted to online accessibility requirements with opposition, passive ignorance, acts of omission, and an unwillingness to embrace change (Wentz, 2011). The caveat related to the choice between access and a financial burden has allowed universities to delay efforts to upgrade their existing courseware. It is imperative to recognize that compliance with policy will lead to potentially endless delays in true access as long as there remains room for interpretation in the law. Therefore, it can be concluded that true progress on a national or universal scale may only be possible with further policy reform.

Whether it be national or institutional policies, faculty and administrators have expressed concerns that specific accessibility requirements limit the creative freedom of academic professionals and that continued policy changes will result in extreme resource limitations. Additionally, the majority of university structures and attitudes are such that there is a lack of top-down support during budgeting conversations and a suppression of discussion about the need for greater access on an institutional level. This means that it may be a long time before further policy revisions are made (North, 2002).

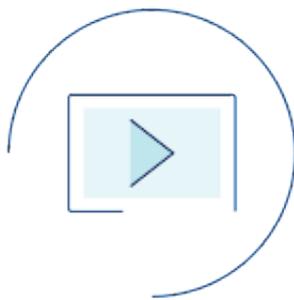
Reactive accommodation

Reactive accommodation is an approach in which institutions wait for students to request accommodations on a need-by-need basis. Even if not done so intentionally, this is often the result of a lack of forethought when it comes to accessibility in courseware design; conversations about accessibility and inclusion are often put aside until design plans are 80-90% complete, leaving little room for correction and resulting in the need to retrofit solutions as accessibility barriers become apparent (Steyaert, 2005). This becomes problematic when as high as 40% of students with disabilities do not report their needs for accommodation to their university (Dell, 2015; Kent, 2015). Furthermore, those who do request accommodations may not know what to ask for or wait until it's too late to ask.

In the long run, institutions using reactive accommodation face high design and legal expenses. In addition, there are many students who are given haphazard arrangements that do not provide learning opportunities equal to those available to their peers. For all of these reasons and more, it is clear that the reactive accommodation approach should be avoided at all costs. Therefore, it is imperative that accessible solutions are identified and implemented while the technologies and infrastructures in postsecondary educational institutions are still early in the developing stage (North, 2002; Wentz, 2011; Toshio, 2016).

Vendor approaches to evaluating courseware accessibility

The previous section described the various approaches that institutions may apply to courseware design and development. We now turn our attention to courseware product vendors, who can apply a few different methods for categorizing the needs of potential courseware users in an effort to assess the accessibility of their courseware products. While one method is not inherently superior to the others, it is important to be on the same page as the institution procuring the courseware product being developed. This will help ensure that gaps left by any of these evaluation approaches are filled. The most common approaches described in the literature include evaluating by **media type, interaction level, and ability level**.



Media Type



Interaction Level



Ability Level

Evaluating by media type

There are many types of media that students will encounter as they interact with courseware in higher education, including printed text and images, digital text and images, the internet, and both audio and video recording and conferencing. Evaluating by media type separates the task of improving accessibility into the mode of delivery of the courseware an instructor designs. This is an important factor to consider because as many as one-third of students who use assistive technology to access online educational material find that this material has unreliable or inconsistent access at a basic level (Tosho, 2017).

Evaluating by interaction level

There are three primary levels of interaction – hardware and software, course content, and user support – between a student and their courseware (Fichten, 2001; Rowland, 2002). While these levels of interaction are dependent on one another, considering each one in turn will allow vendors to survey the landscape of users’ needs in the order in which key development decisions are made. Users’ needs must be met at all levels to ensure uninterrupted access to courseware.

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- **Level 1, access to hardware and software**, is the foundation upon which the other two are dependent. It is important for courseware developers and designers to consider the cost and usability of hardware, such as computers, and software, such as specific applications, required with the courseware as well as its integration with the institution's existing technologies (Fichten, 2001). Missing this logistical step will mean access is limited before any content is presented.
- **Level 2, access to course content**, incorporates both the format in which the content is made available as well as the content itself. The broad content components of courseware are learning supports, learning resources, and learning tasks (Agostinho, 2002; IMS, 2004).
 - o Learning supports include navigational elements, schedules, procedures, and instructions within the courseware. These are the logistical elements of the courseware, which must be accessible before the learning resources and learning tasks become relevant.
 - o Learning resources are books, articles, websites, lectures, electronic devices, and case studies. Every resource must meet the accessibility needs of all students.
 - o Learning tasks are problems, projects, interactive tutorials, interactive exercises, and role plays. Each task must meet the accessibility needs of all students.
- **Level 3, availability of user support**, covers any ground left exposed in the first two levels. Courseware with sufficient user support will have a team prepared to guide users through any accessibility challenges. Again, it is strongly advised to assign a person or persons to take responsibility for ensuring this support is available both within the institution and from the courseware provider. The purpose of this support is to increase responsiveness to the needs of the community through all mediums (email, website, phone). A long-term view can provide greater emphasis on the importance of this level, as the need for support will decrease the more it is utilized to fix user issues up front (Rowland, 2002).

Evaluating by ability level

The most comprehensive and useful version of this approach would involve the consideration of all the potential "types of students" who may be interacting with your courseware. This type of audience identification exercise would enable you to capture more than just groups of students separated by ability level. However, today this approach is limited only to students with disabilities, leaving out all other potential barriers to access and use of courseware that a student may encounter.

There is much debate over the best way to categorize the types of disabilities, but common categories include learning disabilities, physical disabilities, hearing impairments, vision impairments, cognitive disabilities, and other factors such as emotional disorders and medical conditions (North, 2002; Pearson, 2002; IMS, 2004; Dell, 2015; Burgstahler, 2017; Trent, n.d.).

Key players

Institutions and other organizations

To date, there are dozens of institutions that have adopted web accessibility policies (Burgstahler, 2014). For example, the Massachusetts Institute of Technology (MIT) has an objective of increased web accessibility to build cultural awareness and acceptance of the benefits of accessibility. With a policy of regular reviews that include both code and design, MIT employs a variety of methods to pressure test the various web applications and products students are expected to use. The school uses a combination of the multidisciplinary approach and user-centered design to develop accessible courses, including web-based courseware when applicable. Some other noteworthy institutions with robust accessibility policies include the California Community Colleges, Harvard University, Ohio State University, and the University of Kansas Medical Center.



There are several US organizations making global contributions to the conversation around inclusive and accessible courseware (California, 1999; Coombs, 2000; Harrison, 2000; North, 2002; IMS, 2004; Burgstahler, 2015). Perhaps the most well-known organizations in this space are the World Wide Web Consortium (W3C) and the WAI Accessibility References, both of which contribute resources, tools, and research to the broader field of web accessibility. Equal Access to Software and Information (EASI) also provides information and guidance related to the access of information for people with disabilities, hosting online webinars to teach higher education representatives how to design more accessible courses by addressing various software platforms in turn. Finally, The Trace Research and Development Center at the University of Maryland is responsible for the development of **most of the technologies and tools** that provide greater access to technology for students with disabilities.

There are also many Canadian organizations conducting research and developing tools related to courseware and web accessibility (California, 1999; Coombs, 2000; Harrison, 2000; North, 2002; IMS, 2004; Burgstahler, 2015). For example, the Inclusive Design Research Centre (IDRC) at the University of Toronto created standards for courseware developers then released their A-Prompt tool and their SNOW website to assist vendors and instructors in prioritizing accessibility. The IDRC also provides public access to courseware product comparison results. Similarly, the CPB/WGBH National Centre for Accessible Media (NCAM) is a research and development facility that works to make media accessible to underserved populations such as persons with disabilities, minority-language users, and people with low literacy skills. Lastly, the Accessible Web Authoring Resources and Education Centre (A WARE) serves as a web accessibility resource for course authors, specifically.

Vendors

Several vendors have been recognized by researchers and users of adaptive courseware for their extraordinary attention to the need for consideration of inclusion. The Inclusive Design Research Centre (IDRC) at the University of Toronto performed two noteworthy courseware comparison studies, identifying and scoring the following courseware products on both accessibility and support: CourseInfo, WebCT, Web Course in a Box, TopClass, Virtual-U, and Mallard (Inclusive, 1999; Inclusive, 2000). Pearson created and implemented their own accessibility standards to which they hold themselves and others accountable (Pearson, 2002; Pearson, 2009).



Software programs such as Adobe, Corel, Macromedia, and Microsoft Office, feature accessibility components including on-screen keyboards and magnifiers (Steyaert, 2005). The learning management systems (LMS) Blackboard and WebCT have made explicit declarations about their attempts to improve the inclusivity of their interfaces by providing alternative text for all images, optimizing content for use with screen readers and providing manuals to instructors on how to author content that meets accessibility requirements (Steyaert, 2005). Smaller universities gravitate towards platforms like BbLearn and Moodle for their LMS needs, but no accessibility features are available for these at this time (Edutechnica, 2014).

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Part II: Framework of Accessibility Approaches

A summary of approaches to developing and evaluating accessible and inclusive courseware

Questions Addressed

What is the relationship between the various approaches described in the research brief?

What is the expected outcome following the use of each approach?

Key Insights

The outcome of the approach used by an institution may vary depending on the method of evaluation used by the vendor.

It is important that institutions and vendors communicate about the expectations for accessibility throughout the design and development processes.

Introduction

This document serves as a visual synthesis of the approaches described in the research brief, with the intent of providing institutions and vendors working to improve courseware accessibility with an understanding of the landscape of approaches that exist to develop and evaluate courseware, respectively. This framework is intended to help you identify where you are, where you want to be, and what improvement looks like for you as an institution. If you are seeking additional guidance on how to select an approach, please visit the Approach Selection Matrix.

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Of course, institutional representatives should work in partnership with vendors towards developing more accessible courseware. This is a goal that all parties ought to be aligned on due to the shared and unavoidable ethical responsibility. However, vendors today have little incentive to be proactive in their efforts to improve accessibility in their products, so the bulk of the responsibility lies with institutions who have the legal guidance, moral obligation, and customer demand power to drive the development of more customizable and accessible courseware.

How to interpret the framework

Along the left-hand side of the framework below, you will see the five methods that institutions use today to address courseware accessibility. We have organized them in order from most effective at the top to least effective at the bottom. The approaches do not have to be used on their own; some combination of multiple approaches may end up providing the most effective solution for your institution. Along the top of the framework, you will see the three evaluation approaches that vendors use today for assessing courseware accessibility. In order to ensure there are no gaps in the assessment process, it would be best to use all three evaluation approaches. In other words, the most thorough review of your courseware will use some combination of the three evaluation approaches.

By positioning the approaches in this format, we are able to define the consequences that may come with the employment of each. This is not meant to provide you with detailed instructions on how to employ any of the given approaches, but rather to help you be more aware of the current status of your courseware. You can use this framework to gain a glimpse of how well your institution is currently addressing accessibility issues related to courseware and a general idea of what you might need to do to improve your current standing.

If you find that your institution is employing an approach that does not tend to yield satisfactory outcomes for students, we hope you will feel obligated to take action. Approaches that leave only some of the media types, interaction levels, and/or ability levels addressed should be employed with caution. For any approach to be successful, we recommend that you incorporate conversations about accessibility into the earliest stages of your courseware planning process.

We suggest that you work with your courseware vendors to identify what you can do together to improve the accessibility of your current and future products. As a customer, you have leverage to insist change happens – and it happens fast.

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Approach	Evaluating by media type  Eg. Text, images, audio, video, etc.	Evaluating by interaction level  E.g. Hardware & software, content, support	Evaluation by ability level  E.g. Learning disabilities, hearing impairment
Universal Design Mandated overhaul  E. g. Structure, layout, and patterning of navigation	Universally designed solutions available for all media types.	All levels of interaction with courseware are universally accessible.	All students have access to courseware.
Multidisciplinary design  E.g. Content, development, pedagogy, technology	Most media types are designed to be inclusive and accessible.	Hardware/software and support are inclusive and accessible, but content may present some accessibility barriers.	Most students will not face any barriers when accessing courseware.
User-centered design Allows users to customize  E.g. Cognitive styles, strategies, subject matter knowledge	Most media types are designed to be inclusive and accessible.	Hardware/software and content are inclusive and accessible, but support is not as customizable.	All students have access to courseware.

Inclusive Instruction with Adaptive Courseware

Approach	Evaluating by media type Eg. Text, images, audio, video, etc.	Evaluating by interaction level E.g. Hardware & software, content, support	Evaluation by ability level E.g. Learning disabilities, hearing impairment
<p>Design to policy standards Bare minimum</p>  <p>E.g. video lecture closed captioning, Alt text</p>	<p>Most media types are designed to be inclusive and accessible.</p>	<p>Hardware/software and content are accessible most of the time, though not always providing the same learning experience for all students. Legal requirements do not include available support.</p>	<p>Not all ability levels and student types will find courseware equally accessible.</p>
<p>Reactive accommodation Need-by-need basis</p> 	<p>Some media types are designed to be inclusive and accessible.</p>	<p>None of the levels of interaction are sufficiently accessible.</p>	<p>Not all ability levels and student types will find courseware equally accessible.</p>

Part III: Accessibility Approach Selection Matrix

This decision-making tool can be used as a way to make comparisons between the approaches described in Part I to identify the weaknesses of an institution's selected approach. In either case, the ultimate aim of this tool is that institutions will feel equipped to make an informed decision about their approach to improving the accessibility of their courseware products.

Questions Addressed

- How does one know which approach to developing accessible and inclusive courseware products is best suited for their needs?
- What differences are most important to consider when it comes to comparing approaches for developing accessible and inclusive courseware?

Key Insights

- While the relative effectiveness of each approach is clear, this may not be a useful way to determine which approach is most appropriate in a given scenario.
- There are a number of ways in which the approaches introduced in our research brief vary. These may carry different weights depending on your institution's situation.

How to read the matrix

We selected five dimensions across which we have compared the five approaches, as shown in the table below. Those dimensions include:

1. **Popularity:** An indicator of the relative prevalence of the approach across institutions today. This should give you a sense of the amount of guidance you'll be able to find in implementing your selected approach.
2. **Stakeholder involvement:** An indicator of the relative human capital required to accomplish this approach effectively, which will be dependent upon the level of experience had by the faculty leading the development process. There are many stakeholders involved in the processes of courseware development and piloting, so a higher rating in this category indicates that more of them are involved in the process beyond a consultative role.
3. **Time investment:** An indicator of the relative amount of time required to complete the courseware design process using this approach.
4. **Cost investment:** An indicator of the relative financial investment required to complete the courseware design process using this approach.
5. **Effectiveness:** An indicator of the relative degree to which this approach will provide students and end users of the courseware with a product that has little to no accessibility barriers. This includes the degree to which instructional support will be available during implementation and use of the courseware.

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To use the matrix, you will first need to rank your institution across each of the five dimensions described above. Eliminate the approaches that demand more human capital, time, and/or funding than you have available. From the remaining approaches, select the one that best suits your needs in terms of popularity and effectiveness. Keep in mind that a combination of multiple approaches may be the most effective and that each approach's weaknesses will be mitigated or exacerbated depending on the evaluation method employed by your courseware vendor. To learn more about the interplay between approaches and evaluation methods, check out our Framework of Accessibility Approaches.

Selection matrix

High  Medium  Low 

Approach	Popularity	Stakeholders	Time	Cost	Effectiveness
Universal Design Mandated overhaul  E.g. Structure, layout, and pattern of navigation					
Multidisciplinary design Phased approach  E.g. Content, development, pedagogy, technology					

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High 

Medium 

Low 

Approach	Popularity	Stakeholders	Time	Cost	Effectiveness
<p>User-centered design Allows users to customize</p>  <p>E.g. Cognitive styles, strategies, subject matter knowledge</p>					
<p>Design to policy standards Bare-minimum</p>  <p>E.g. video lecture closed captioning, Alt text</p>					
<p>Reactive accommodation Need-by-need basis</p> 					

Example scenario

Halfway through her courseware design process, an administrator realizes her team has had no conversations about accessibility and inclusion. She knows she has **limited human capital and time**, but she does have **room in her budget** for a large investment to repair her mistake. She knows that her institution has an **accessibility team** she could tap for assistance, so she needn't worry whether there are many examples of other institutions utilizing the approach she selects. Ultimately, she wants something that **works well** but can be applied effectively given her constraints. She consults the selection matrix to identify which approach would be most appropriate for her to use at this point. A process of elimination and a prioritization exercise help her determine that a combination of the user-centered design approach and the multidisciplinary design approach will be best.

Part IV: Table of Media Types

The table below summarizes the types of media most commonly incorporated into courseware and explains the advantages of different mediums as well as the challenges they may present to users. Development solutions to the challenges are provided (California, 1999; IMS, 2004; Distance, 2011; Hanover, 2011; Burgstahler, 2015; Toshio, 2017). Of note, there are several other media types that present challenges to students in an academic environment but that may be less commonly employed within adaptive courseware. More research is needed to determine the best methods for ensuring that these media types are accessible and inclusive: Presentation tools, collaboration tools, asynchronous messaging systems (email, message boards), instant chat systems, document repositories, and calendars/schedulers (California, 1999; IMS, 2004; Distance, 2011; Hanover, 2011; Burgstahler, 2015; Toshio, 2017).

Media Type	Pros for accessibility and inclusion	Cons for accessibility and inclusion	Suggestions for improving access
Print text and images	Easy to handle and transport; materials are readily available; students can work at their own pace	No multimedia reading assistance; low aid for comprehension; low interactivity	Braille, audiotape, large text, screen magnification, text to speech
Digital text/ images and the World Wide Web	Low delivery cost; easy resource development; variety of media and interactivity	Lack of adequate alternatives for those who cannot see or read; potential challenges with navigation when using inconsistent website layouts	Refer to WAI guidelines for web accessibility

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Media Type	Pros for accessibility and inclusion	Cons for accessibility and inclusion	Suggestions for improving access
Audio recording	Inexpensive materials; easy to duplicate	Lack of adequate alternatives for those who cannot hear or require the ability to learn at their own pace; lack of interactivity to ask questions	Speech-to-text tools, written content descriptions
Audio conferencing	Increased interactivity; generally good voice quality	Lack of adequate alternative for those who cannot hear or respond quickly enough to conversations	Speech-to-text tools, interpreter/aid at student's location, chat feature
Video recording	Has both audio and visual elements; opportunity to include descriptive narration	Lack of interactivity to ask questions	Closed captioning, speech-to-text, screen magnification, content descriptions
Video conferencing	Real-time interaction (best alternative to face-to-face)	Expensive equipment and internet tools required, challenge for some to respond in real time	Speech-to-text, screen magnification, content descriptions, student aid, chat feature

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Disability category and prevalence (% of all disabilities)	Recommendations to make courseware more inclusive/accessible
<p>Learning disabilities – 28%</p> <p>E.g. Attention deficit disorder, memory impairments</p>	<p>Have electronic and printed forms; ensure product support team is aware of disability access needs; communicate with product developers/designers regularly; ensure compatibility with speech recognition software</p>
<p>Physical disabilities – 15%</p> <p>E.g. Motor impairments</p>	<p>Avoid timed responses; provide keyboard access to all toolbars, menus, dialogue boxes; don't disable access features built into the system (ex. Sticky keys); provide alternative input mechanisms and easy navigation controls</p>
<p>Hearing impairments – 6%</p> <p>E.g. Deafness, hard of hearing</p>	<p>Provide visual options for all auditory information (both transcripts and captions are useful); ensure all visual cues are noticeable without one looking at screen; have a mode of operation without sound</p>
<p>Vision impairments – 3%</p> <p>E.g. Blindness, low vision, color blindness</p>	<p>Allow user to adjust fonts, colors, cursors, ensuring program can operate in a monochromatic mode; use high contrast between text and background (and no text over patterned background); make color coding redundant with other means of conveying information; use colors that differ in "darkness" as well as color; use a consistent and predictable screen layout for dialogues within program, including standard line widths and single-column text; provide access tools via a menu bar and provide keyboard access to all tools, menus, dialogue boxes; make system cursor appear even if using your own highlight/focus techniques; use text labeling for all images and provide running audio descriptions of all moving graphics and videos; give controls logical names; avoid pop-ups; make text known to screen reading software; ensure compatibility with screen readers and magnifiers</p>

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Disability category and prevalence (% of all disabilities)	Recommendations to make courseware more inclusive/accessible
<p>Cognitive disabilities – 1%</p> <p>E.g. Language and speech impairments</p>	<p>Make all alerts stay on screen until dismissed; make language simple and straightforward; use simple/consistent screen layouts</p>