

Improving Learning

Rapid review of effective practice principles in the design and delivery of digital resources for teachers

Part of the Life Education Australia *Being Healthy, Being Active* project

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Rapid review of effective practice principles in the design and delivery of digital resources for teachers

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Executive summary

One of the outcomes and challenges of the COVID pandemic has been that schools and training providers are more actively seeking ways in which they can use digital learning techniques and tools to provide continuing professional development for teachers.

Professional learning is increasingly expected to be self-paced, self-directed and virtual, and teachers are increasingly expected to upskill themselves, often working remotely, using electronic (e) – resources and online collaborations. While this is a practical means of delivering professional learning to teachers during difficult times, it raises questions for professional learning providers about the best way to design online resources and knowledge repositories for teachers.

This rapid review gathered evidence about effective practice and principles in the design and delivery of digital resources for teachers and specifically, to inform principles to guide the design and delivery of digital resources for teachers as part of Life Education Australia's *Being Healthy, Being Active* project. The overall research question for this rapid review was: *What does the research evidence say about the design and delivery of digital online resources for teachers and what practice implications and recommendations could be made based on this research evidence?* It addressed three specific questions:

1. With regard to online learning platforms for the delivery of resources to teachers: how are these platforms meaningful, engaging and user-friendly?
2. Which modes and formats of online resource delivery are most appropriate to reach teachers, particularly those in rural and remote areas?
3. What modes and formats of online resources could be best used by Life Education Australia for the *Being Healthy, Being Active* project?

The rapid review applied five steps streamlined from a traditional systematic search process to meet the timeline available for the project: scope; question; scan; screen and select; and synthesise evidence. The literature included in the scan was drawn from two key education databases, the Australian Education Index (AEI) and Education Resources Information Center (ERIC). Systematic database searches returned 767 references and after careful screening and selection using stated inclusion and exclusion criteria, 28 papers were included in the review.

From this literature, five fundamental design principles for digital professional learning resources were identified:

- Principle 1: Relevance: meeting teachers' needs
- Principle 2: Educational value: focusing on learning
- Principle 3: Managed and flexible learning environment
- Principle 4: Social presence: participants are engaged with the content, facilitator and peers
- Principle 5: Quality content: using diverse media drawn from reputable sources

Evidence indicates that applying these principles for the design and delivery of online teacher resources will help to ensure that teachers find the learning materials and tools to be meaningful, educationally sound and user-friendly. Therefore, teachers will be able to learn more effectively, become more confident in applying their newly acquired knowledge and ultimately transfer these skills to their classrooms to improve student engagement and learning outcomes.

This review identifies evidence available globally for online teacher professional learning programs and highlights some key features which have been adopted across these programs.

Glossary

Asynchronous	Participants are not physically present at the same time as each other and learn in their own time
Blended	Content delivery occurs in both face-to-face or in-person and online or remote modes
cMOOC	Connectivist Massive Open Online Course involving groups of people learning together
Cognitive presence	The extent to which participants construct meaning in a learning environment through sustained reflection and critical discourse
CSER	Computer Science Education Research Group based in the School of Computer Science at the University of Adelaide
Face-to-face	Participants and facilitators are located in the same physical location
Intervention	In the context of education, an instructional intervention is a specific set of steps or a formal program used to target a learning need
LMS	Learning Management System
LEA	Life Education Australia
Livestreaming	Making visual and/or audio material available for viewing via the internet at the same time as a facilitator is presenting. Often a recording is made at the same time
MOOC	Massively Open Online Course
Online learning resources	Learning materials such as e-books, slides, videos, podcasts etc. that are available through the internet via some platform (such as website or Learning Management System)
oTPD	Online Teacher Professional Development
PCK	Pedagogical Content Knowledge whereby teachers transform subject content for learners
PL	Professional Learning
PD	Professional Development
Remote delivery	Participants and facilitators are not in the same physical location as each other
Self-directed	Participants access learning materials independently and proceed at their own pace, often with some guidance
Self-determined	Participants take initiative for identifying learning needs and goals, looking for the resources, and implementing the complete learning process
Social presence	The extent to which a person feels socially connected to others in their learning environment
Synchronous	Participants attend to learning at the same time as the facilitator and/or other participants, whether in-person or online
Teacher presence	The extent to which a learner feels connected to the teacher or facilitator in their learning environment
TMPL	Technology-Mediated Professional Learning
TPACK	Technological Pedagogical Content Knowledge
xMOOC	eXtended Massive Open Online Course delivered by an instructor with limited interaction

1. Background

The aim of this rapid review was to gather evidence about effective practice principles in the design and delivery of digital resources for teachers. Life Education Australia (LEA) is preparing to roll out online learning resources for teachers and intends to be informed about the current evidence on the successful implementation of such resources. Ideally, the evidence coming out of this rapid review will inform the development of principles to guide the design and delivery of LEA's digital resources for teachers.

1.1 Rationale

The Coronavirus pandemic (COVID-19) meant distance learning and teaching became the only possible way to deliver education in many countries across the world. Distance or remote learning is mostly taking place through online platforms, and it is expected that teachers should not only know how to navigate and use these online resources, tools and learning systems but should also be using these for their own learning and professional development.

Pre-2019, online learning was already a powerful medium for delivering low-cost, high-quality, and accessible training to teachers, particularly to those in rural and remote locations (Bragg et al., 2021; Dede, 2016). However, while prior work has identified successful design elements for the delivery of online teachers' learning programs, there remains a gap in understanding how these design elements, such as learner supports, "assist teachers in gaining knowledge and skills through interactives or engaging in self-reflection through metacognitive interactives" (Bragg et al., 2021, p. 11).

In the wake of the pandemic, schools and training providers are actively seeking ways in which they can use digital learning techniques and tools to provide continuous professional development for teachers. For such attempts to be successful there is a need to synthesise effective principles and techniques for online learning, and to understand which remote learning modes and formats should be used in different scenarios to facilitate teachers' ongoing learning goals.

Of particular interest are the design features of teachers' online resources and knowledge repositories. As learning is increasingly expected to be self-paced, self-directed and virtual for at least a while, driven by the current pandemic, teachers will be expected to upskill themselves while working remotely, using electronic or e-resources and online collaborations – an effective means of delivering professional learning and development opportunities to teachers during difficult times.

1.2 Prior research

There is literature available on the different approaches to synchronous online learning (Martin et al., 2017), and general reviews of online education (Sun & Chen, 2016). Lately, researchers have also explored the remote learning methods applied in schools that have been used during the pandemic (Education Endowment Foundation [EEF], 2020a), with a focus on *student* learning.

Research on the use of online learning platforms by teachers for their own professional development is still evolving. An earlier paper helped to identify circumstances where online learning for teachers was most useful and where it could be challenging (Bates et al., 2016). Others have developed concepts around self-directed online learning behaviours useful for understanding how teachers use online professional learning resources (Beach, 2017). Research suggests the design of effective e-learning resources and systems needs to

accommodate specific teaching and learning needs, and to promote interaction between teachers and students to increase teachers' motivation to use e-learning systems (Schulz et al., 2014). When the e-learning environment is perceived by teachers to be useful, they are willing and motivated to use these systems (Liaw et al., 2007). Additional factors such as level of computer integration, positive beliefs, ease of use, training, and support also influence the teachers' motivation to use e-learning systems (Schieb & Karabenick, 2011).

A study which explored teachers' learner-centred beliefs and attitudes towards technology identified five major teacher types: 1) Learner-centred teachers with technology, 2) Teachers critical of technology use in school, 3) Teachers uncomfortable with technology, 4) Teachers uneasy with learned-centred teaching and 5) Teachers critical of a clear-cut stance (Admiraal et al., 2017, p. 57). This grouping of teachers was considered useful for matching the right group of teachers to a particular intervention, or to design different digital learning resources for teachers with different attitudes.

Previous reviews have focused mainly on the broad topic of distance or digitally supported professional development and suggested that remote professional development programs can improve the knowledge and skills of educators and therefore lead to improved student outcomes (Basma & Savage, 2018; EEF, 2020b; Kraft et al., 2018; Marsh & Mitchell, 2014). Besides, researchers agree that some design and implementation features are paramount for the success of these distance learning programs (Basma & Savage, 2018; Lynch et al., 2019; Major & Watson, 2018; Reeves & Pedulla, 2013). A recent systematic review suggests key design elements that lead to effective online professional learning delivery which can improve teachers' knowledge, skills, beliefs, and practices (Bragg et al., 2021). Table 1 lists a number of relevant reviews and also notes their key characteristics.

Table 1. Previous reviews related to teacher professional development including blended, hybrid, online, electronic, and distance learning initiatives

Authors	Title	Approach	Outcome	No. of studies	Focus teacher PL	Reports program design
Basma & Savage, 2018	Teacher professional development and student literacy growth	Systematic review and meta-analysis; video exemplars	Student literacy	17	Y	Y
Bragg, Walsh, & Heyeres, 2021	Successful design and delivery of online professional development for teachers	Systematic review of literature on online PD programs	Teacher's content knowledge, PCK, instructional practices, professional competency, classroom management practices, teacher beliefs, perceived sense of self-efficacy, and program satisfaction	11	Y	Y
Cho, Mansfield & Cloughton, 2020	The past and future technology in classroom management and school discipline	Systematic review; Videos, interactive simulations, databases	Teacher classroom management knowledge and skills	22	Y	Y

Authors	Title	Approach	Outcome	No. of studies	Focus teacher PL	Reports program design
Education Endowment Foundation, 2020b	Remote professional development	Rapid evidence assessment of remote (fully or blended) PD approaches for professionals in education, welfare & public health	Beneficial outcomes, professionals' behaviour or knowledge change, other outcomes (such as job satisfaction)	17	N	Y
Hundey, Anstey, Cruickshank & Watson, 2020	Mentoring faculty online	Literature review of online mentoring	Teaching confidence, knowledge and skills	17	Y	Y
Kraft, Blazar & Hogan, 2018	The effect of teacher coaching on instruction and achievement	Meta-analysis of teacher coaching	Teacher instruction, student achievement	60	Y	Y
Lay, Allman, Cutri & Kimmons, 2020	Examining a decade of research in online teacher professional development	Literature review of online PD programs	Teachers, students and oTPD; teachers and oTPD; incidental teacher learning during oTPD.	73	Y	Y
Lynch, Hill, Gonzalez & Pollard, 2019	Strengthening the research base that informs STEM instructional improvement efforts	Meta-analysis of STEM teacher development programmes	Student achievement	95	Y	Y
Major & Watson, 2018	Using video to support in-service teacher professional development	Video-based PD	Teacher cognition and classroom practice	82	Y	N
Marsh & Mitchell, 2014	The role of video in teacher professional development	Video-based PD	Teacher knowledge and skills	Not reported	Y	Y

Although most of the reviews undertaken in this space have tried to identify certain design and implementation features that are widely effective for distance learning situations and generally for teacher professional development, there is a gap in evidence on effective principles in design and delivery of digital resources for teacher professional learning. This calls for a review of the existing digital / online learning approaches, including any online professional learning and development initiatives for in-service teachers and a comparative analysis of the methods and formats used across them.

2. Method

2.1 Rapid literature review

The primary method used for this project was a rapid review. While systematic reviews may be the gold standard for evidence synthesis, rapid reviews are increasingly popular as useful, timely and less resource-intensive than traditional systematic reviews, making them more appropriate in situations where time and budget are limited (Garritty et al., 2020). However, since a rapid review is not as rigorous as a systematic review, which usually takes over a year to complete, users must be mindful of the limitations and potential biases in the selection of evidence for the analysis and synthesis. The steps in a rapid review are usually streamlined from that of a traditional systematic review and a few steps may also be omitted to save time (Temple University, 2021). There is no universally accepted process for conducting such a review, however the stages shown in Figure 1 have been adapted from an approach proposed by Khangura et al. (2012) to provide a systematic basis for this review.

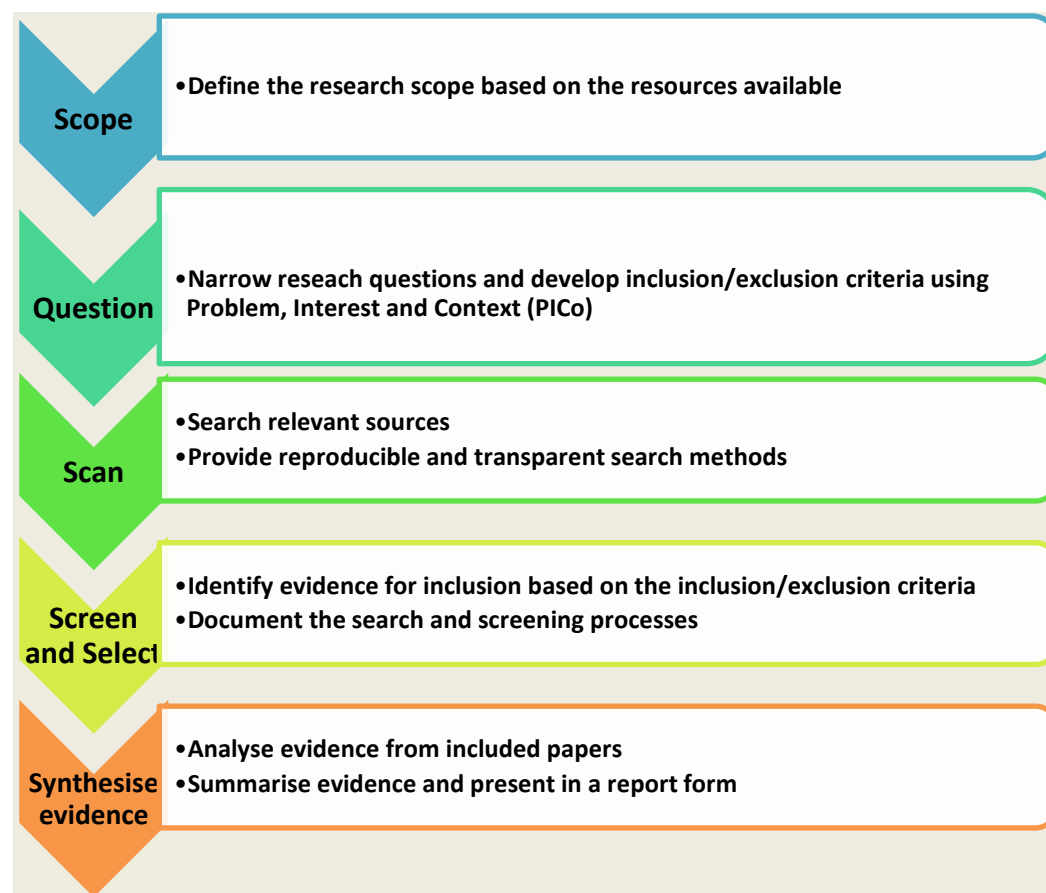


Figure 1. Stages for a rapid review of literature adapted from Evidence summaries: the evolution of a rapid review approach (Khangura et al., 2012)

2.2 Research questions

The following broad research question was developed based on the research questions in the Request for Quote:

What does the research evidence say about the design and delivery of digital online resources for teachers and what practice implications and recommendations could be made based on this research evidence?

More specifically, this rapid review focused on the following key questions to answer the broader research question:

1. With regard to online learning platforms for the delivery of resources to teachers: how are these platforms meaningful, engaging and user-friendly?
2. Which modes and formats of online resource delivery are most appropriate to reach the teachers, particularly those in rural and remote areas?
3. What modes and formats of online resources could be best used by Life Education Australia for the *Being Healthy, Being Active* project?

A framework developed for the review considered a set of key components of effective design and delivery of digital professional learning resources for teachers, including:

- types of digital education resources for teachers
- delivery mode of professional learning resources
- delivery platform
- design elements and features
- outcomes (for teachers)
- outcomes (for students)

The framework is tabled in Appendix 2. This supported the recording and analysis of the evidence included in this review based on a set of inclusion and exclusion criteria.

2.3 Inclusion and exclusion criteria

A set of Problem, Interest, and Context (PICo) dimensions was developed in consultation with the Life Education Australia team to ensure the relevance and usefulness for their planned online resource design. Table 2 shows the inclusion criteria that were applied for searching and screening evidence.

Table 2. Inclusion criteria

Inclusion criteria for this review	
Problem (P)	Providing quality online resources to all in-service teachers (Kindergarten to Year 12 schools), including those in mainstream and or special education settings, and those from rural and remote areas.
Interest (I)	Successful design and delivery elements/ features of distance/ online teacher professional development resources. Includes design features and elements of any online facilitated course (synchronous or asynchronous), mentoring, coaching, networking, self-directed learning module, online teacher resources repository, etc.
Context (Co)	Online learning for teachers across Australia and other developed countries, particularly those with similar educational and technological advancement as Australia, such as Canada, United Kingdom and other European countries.

Table 3 shows other eligibility criteria detailing the exclusions and limits use in the review.

Table 3. Exclusion criteria

Exclusion criteria for this review	
Scope	Limit the scope to in-service teacher learning, rather than pre-service teacher education or professional learning for adults outside the teaching profession.
Timeframe	Limit the timeframe of the publication date from 2010 to 2020.
Relevance	Exclude evidence focused on face-to-face instruction, blended learning (components of face to face and online instruction), and self-determined learning not conducted entirely online, computer-assisted learning, field placements or professional development programs as part of teacher training at tertiary level institutions.
Relevance	Exclude papers from countries whose educational technology availability, and the teacher population, differ vastly from the Australian context.
Data availability	Exclude books, dissertation, theses and papers which are not easily available in full-text in the timeframe for the rapid review.
Language	Exclude papers not available in English.

2.4 Systematic searches and selection of studies

The literature search drew on two key education databases, the Australian Education Index (AEI) and Education Resources Information Center (ERIC). Both databases have an education-specific thesaurus that were used to ensure inclusion of strategic search terms to match the PICo dimensions. The search was limited to evidence from 2010 or later since technology-based approaches prior to 2010 are unlikely to be relevant. The full search syntax for each database is included in Appendix 1.

The systematic database searches returned 767 references. After removing duplicates, 720 records were screened on title and abstract, and another 88 references were selected for full text screening. The full text for 14 references could not be retrieved and so 74 full texts were thoroughly screened. These papers identified through systematic searches were screened against the inclusion and exclusion criteria discussed in Section 2.3.

Of these 74 papers, 28 papers were included in the review. All 28 had data extracted, noting that there were two separate references to the same study (Allen, 2011 & 2015). These papers are separately identified in the Reference list. Appendix 3 contains a summary of the papers in terms of delivery mode, level of facilitation, intervention details, date, country, the content or subject area focus, length of intervention, learning platforms used, purpose and outcomes.

Potential additional papers to inform the development of principles were pursued through hand searching of reference lists, and specific searches of relevant grey literature.

2.5 Evidence synthesis and presentation

The key objective of this step was to summarise what is known about effective practices in the design and delivery of digital or online resources for teachers in the literature.

This stage involved: 1) extracting relevant information from the included papers; 2) summarising the evidence; and 3) providing implications for practice and recommendations (Dobbins, 2017).

This framework that supported the recording and analysis of the evidence included in this review is provided in Appendix 2. The purpose of the evidence synthesis, analysis and discussion stage was to help answer the research question:

What does the research evidence say about the design and delivery of digital / online resources for teachers and what practice implications and recommendations could be made based on this research evidence?

3. Analysis of the evidence on effective design of online professional learning resources and programs

This section summarises the findings of the included studies shown in Appendix 3 and categorises the online professional development resources and programs identified in the rapid review. Six examples of principles of professional learning published by Australian and international organisations were mapped and shown in Appendix 4 (Australian Council for Educational Research [ACER], 2013; Cavanaugh & Dawson, 2010; EEF, 2020b; Global Online Academy [GOA], 2020; Quality Matters [QM], 2015; NSW Education Standards Authority [NESA], 2021). These principles were used to inform the analysis of the literature in the rapid review. While this review focuses on the design elements and features which are most effective for the delivery of online teacher professional development, it is important to acknowledge that professional learning is a complex activity and it is not readily dissected into component parts for the purposes of research, but is inherently holistic, dynamic and contextual (Timperley et al., 2020, p. 3). There are many components that contribute to effective professional learning and this review picks out those elements that most directly relate to the design of online professional learning.

3.1 Effective professional learning

To evaluate the effectiveness of professional learning there must be a standard against which to compare, and a means of measuring the outcomes. As the outcome of a program or resource cannot be evaluated until after it has been implemented, organisations often develop a set of principles to guide the development of professional learning. Examples of guidelines for effective professional learning are presented in Appendix 4: Good practice principles of professional learning.

Despite the variation in level of detail in these statements of principles of effective professional learning, there are some commonalities, which are represented in Learning Forward's (2021) framework with its three categories of factors influencing the effectiveness of professional learning: (1) *conditions for success* (such as context, structures, and culture); (2) *transformational processes* that ensure educators learn in ways that brings about change in their knowledge, skills, practices, and mindsets; and (3) *rigorous and inclusive content* that aims for improved student outcomes (p. 8).

Literature about effective teacher professional development in the past twenty years shows that there has been a move away from one-time, large group-focussed delivery, towards learning that is needs-based, content-focused, collaborative and ongoing (Borko, 2004; Garet et al., 2001). Another obvious change in the past ten years is the move to professional learning that is delivered online.

3.2 Effective online professional learning

Online professional learning can take a number of forms and can vary in effectiveness – just as is the case with traditional professional learning. There are a great many factors at play, in learning, that must be controlled for in any research that seeks to measure effectiveness of a specific intervention. In the case of online professional learning these factors include the duration, mode, content, learning design, assessment and technology, as well as the knowledge, skills and attitudes of the facilitator and participants. Unsurprisingly, there are relatively few studies on the effectiveness of online professional learning, and it is difficult to generalise from those available (Dash et al., 2012). Teachers work in many different contexts in terms of the level of schooling, teaching area, physical location, educational sector and

student cohorts. Professional learning resources and programs need to take these contexts into account.

One common feature of the literature about online professional learning is that it focuses less on the content and more on the interactions involved in the learning process. The contribution of teacher or facilitator presence is consistently found to improve completion rates and effectiveness of online professional learning (Stone & Springer, 2019). One MOOC that reported an average completion rate of 53% found that learners who were active in the forums were more likely to complete the course (Murugesan et al., 2017).

Many authors make a strong case for inclusion of social interaction and collaborative spaces for teachers in any online professional learning design (Lantz-Andersson et al., 2018). Design that is deliberately flexible, experiential and supports social interaction between participants is regarded as optimal (Eddy Spicer & Dede, 2006). While interactivity is often cited as a feature of online content, in the context of learning, Moore (1989) points out that all three types of interactivity should be involved: learner-to-content, learner-to-instructor, and learner-to-learner (Zimmerman, 2012).

This focus on human interaction is also reflected in design principles for online professional learning. Cavanaugh & Roe (2019) note the absence of Australian standards for online and blended learning in the school sector, and point professional learning designers to the International Society for K-12 Online and Blended Learning (iNACOL) *National Standards for Quality Online Courses* (2011). Adelstein and Barbour (2018), examined the validity and reliability of the iNACOL standards, and found there was limited literature and research specific to K-12 online provision, and that they had to supplement their review with research from higher education and other relevant populations. Since their review, the iNACOL standards have been consolidated with a set of rubrics for designing continuing and professional education (Quality Matters, 2015) to create a new set of standards (National Standards for Quality (NSQ), 2019). This document provides an extensive set of standards in 14 categories that provide further indication of the complexity inherent in designing effective online professional learning programs. These standards are used to guide planning and evaluation of online professional learning. Of particular interest to those developing online professional learning resources, are the standards related to curriculum and course design, instruction, and assessment and learner performance (pp. 18-24).

In critiquing a highly politicised set of Australian online learning resources, Moss (2021), points out that “development of large-scale professional learning resources typically would employ a large team that includes learning designers to work alongside content developers.” Learning design as a specialisation has grown in parallel with the development of online delivery of education, and recognises that more than one skillset is needed to ensure a coherent collation of “content, structure, time, pedagogical strategies, and sequences of learning, assessment tasks and the nature of the technology used to support learning” (Moss, 2021, para 5). As a young profession, the research base underpinning instructional design is emerging.

3.3 Effective design of digital resources for teacher professional learning

This section discusses key findings about the principles underpinning design of digital resources for teacher professional learning, based on the analysis of information from the research included in Appendix 3: *Details of included interventions*, and from a review of instructional design principles. These principles are centred on relevance, educational value, flexibility within a managed learning environment, presence as well as content.

Principle 1: Relevance: meeting teachers' needs

The decisions teachers make regarding resources to use in their own classroom is a complex process based on a range of factors, including in the case of digital content, the extent to which it is “readily accessible, links with the curriculum, and does what it purports to do (Gaffney, 2010, p. 21). This speaks to the first principle of design which is that it meets user needs. Getting close to the intended participants’ context is important. “An understanding of the working contexts of staff is a critical consideration when designing for effective professional development” (Macdonald & Poniatowska, 2011, p. 119).

In order to design online professional learning resources that meet the needs of teachers, it is helpful to know how teachers use such resources. The adoption of digital resources for use with students was the focus of some research in Australia last decade during the rollout of the national digital content initiative known as The Learning Federation (Smith, 2020). This research found that digital resources designed to meet specific elements of the curriculum were highly valued and sites that organised resources according to curriculum themes and topics were popular. Australian resources were particularly valued (Baker, 2010; Maher et al., 2012). In summary, digital educational resources achieve focus on the learning needs of their intended audience when they are:

- contextual – they have purpose and meaning for the intended audience and fit into a learning approach based on the audience’s prior understandings and likely future development
- inclusive – when their language and other features (where applicable) are inclusive of the intended audience (Education Services Australia [ESA], 2011, p. 2).

More recent research reviewing how teachers use digital resources for online professional learning is scarce. The Quality Teachers for Quality Students (QTQS) project, identified in this review, used an online professional learning community to support new STEM teachers, and found this approach allowed collaboration and engagement that could be directed by the needs of the group (Suk Hwang & Vrongistinos, 2012). Professional learning resources and programs that allow for teacher agency in both the design of the program and in how they participate, enhance engagement and learning (Calvert, 2016). This is reinforced in the engagement strand of the popular *Universal Design for Learning* model which refers to “recruiting interest in learning by optimising individual choice, autonomy, relevance, value, and authenticity, and by minimising threats and distractions” (CAST, 2018).

Professional learning principles also stress the importance of adherence to content standards as a measure of relevance. The *NESA Interim Principles of Effective Professional Learning* (2021) are explicit about the importance of ‘coherence’ with the *Australian Professional Standards for Teachers* (Australian Institute for Teaching and School Leadership [AITSL], 2011), with NSW curriculum, and with policy, as well as being “practical, and job embedded” (NESA, 2021).

Ultimately, the best people to consult about the relevance of a resource or service are the intended end-users. This could be via an educator advisory board that provides ongoing input, or through pilot programs where teachers provide feedback about the usability and effectiveness of the resources. “One strategy for optimising the effectiveness of web-mediated professional learning is to design such interventions in collaboration with, and using extensive input from, the teachers who ultimately will use it” (Hindman et al., 2015, p. 15).

Recommendation: Involve teachers in the design, trialling and evaluation of online professional learning programs and resources to ensure relevance.

Principle 2: Educational value: focusing on learning

Educational value is defined by Australia's national agency charged with developing digital teaching and learning resources, as "a resource's capacity to successfully promote learning and development by students, teachers or school leaders within the Australian school context" (ESA 2011, p. 1). The focus of all professional learning must be the learning, specifically, "evidence-informed learning design in which research evidence and data informs co-designed learning that aims to extend and challenge adult learners" (Bastow, 2016, p. 1).

Learning outcomes

Some form of new knowledge and intentional instruction is required if learning is to take place, and the whole process of professional learning design will be driven by effective learning outcomes. Learning outcomes describe the competencies that learners will be able to do upon completion of the program. Intended outcomes for a learning experience should be clearly articulated and participants need time and support to develop their understanding of the meaning and relevance of those outcomes. Instructional materials should enable learners to achieve stated learning objectives or competencies (Quality Matters [QM], 2015). Criteria for assessing educational value include:

- the purpose, process and intended outcomes of the required learning or development are explicit
- the medium is exploited to maximise the opportunities for the audience to achieve the required learning outcomes
- content is constructed in manageable and meaningful concept chunks to facilitate the required learning (ESA, 2011, p. 5).

This assumes the team of content creators and learning designers developing the program and resources are qualified and experienced, and that presenters and facilitators have deep content knowledge and effective teaching skills.

Beach (2017) analysed primary school teachers' use of a professional learning website about teaching literacy and found there were several factors in play before teachers even began interacting with the content, including the teachers' perception of professional learning, their focus that was on student needs and instructional goals, and students' individual differences. Given this was self-directed PD activity, the navigation of the site assumed particular importance, and two key themes emerged: (1) teachers were constantly evaluating information and choosing their pathway through the content accordingly; and (2) they were encoding information for future retrieval. Teachers demonstrated multiple outcomes from the exercise: including reflection on their learning, continued professional learning, and their intentions for practice (Beach, 2017, p. 65). Teachers' engagement in professional learning is essential if they are to learn, and this requires a high level of cognitive challenge.

Cognitive presence

If learning outcomes are carefully constructed, and if the learning design supports these learning outcomes, one might expect the content knowledge obtained by participants to be equivalent, regardless of the mode in which the professional learning is delivered. However, several studies indicate that the level of 'cognitive presence' can change the effectiveness of professional learning. Cognitive presence is defined as "constructing meaning through sustained reflection and discourse in a critical community of inquiry: cognitive presence reflects higher-order knowledge acquisition and application and is most associated with the literature and research related to critical thinking" (Garrison et al., 2001, p. 17). This is often supported by a focus on 3 Rs:

- Relevance – provoking curiosity and establishing connections to prior learning or knowledge
- Rigour – challenging participants to solve problems that are personally meaningful to them
- Relationships – designing a learning environment where participants work collaboratively together in a community of inquiry (Alman et al., 2012).

Within the review, one study about Norway's *Matematikk MOOC* explicitly referenced cognitive presence, and concluded that a meaningful learning experience was created through the interplay of three key elements: social, teaching and cognitive presence. This 3-week program aimed to refine teachers' practice using a Community of Inquiry learning (CoI) model to develop participants' pedagogical content knowledge. The MOOC required collaboration and engagement, with a discussion forum as the main platform for interaction. The facilitator's main role was publishing and explaining problem-based tasks in the discussion forum (Krzyszowska, 2020). It is observed that interaction is not a guarantee that learners are cognitively present in the learning experience, as they can interact, but at low cognitive levels.

Assessment and feedback

In order to demonstrate that learning has occurred, some form of learning assurance task or assessment is required. Assessment strategies are integral to the learning process and are designed to evaluate learner progress in achieving the stated learning objectives or mastering the competencies (QM, 2015). Thus, assessment needs to be consistent with the stated learning outcomes, as well as being valid, reliable, and appropriate to context. Many of the programs in this review included an assessment component (Hilli, 2020; Hindman et al., 2015; Marrero et al., 2010). Demonstration of a teacher's learning ideally involves application of acquired knowledge and skills in practice which can be a challenge for an online professional learning program that is not school-based. Effective assessments are aligned to learners and learning goals, allow for multiple attempts, and support students working at their own pace (GOA, 2020). Online learning programs typically rely on online quizzes and polls, as formative assessment opportunities, as in the *Virtual Live, Short-Courses for NASA Explorer Schools* (Marrero et al., 2010). However, the platform on which professional learning resources are hosted can constrain best practice and cognitive engagement by only offering certain tools for assessment (Hilli, 2020).

Providing opportunities for feedback to teachers and reflection by teachers is equally important (NESAs, 2021). Documenting formal and informal reflection and peer feedback through forum posts is one of the affordances of traditional online learning platforms. Effective learning design can encourage and incorporate feedback in multiple formats, and focus on diversifying feedback channels to include facilitator-to-participant, facilitator to-participant(s) (i.e. groups), participant to participant, as well as participant to facilitator.

Closing the loop on assessment involves using participants' assessment results to evaluate the professional learning activities on an ongoing basis to improve quality (ACER, 2013).

Recommendation: Commence development of online professional learning from a strong shared understanding of the learning outcomes and how to effectively assess teachers' learning of those outcomes.

Principle 3: Managed and flexible learning environment

There is tension between providing a seamless, user-friendly experience for teachers, and at the same giving them flexibility to move through resources in a way that works for them. Online professional learning programs and resources must balance usability and flexibility. The stricter the designer is about consistency and simplicity of navigation, visual elements, chunking of text – the quicker the end-user will learn what they can access, how the platform works and where things are. The Digital Transformation Agency of the Australian Government provides a set of 13 Digital Service Standard Criteria to help design and deliver online services that are simple, clear and fast (Digital Transformation Agency [DTA], 2011). These criteria can be readily applied to design of digital services for education. Education Services Australia also provides very detailed advice to designers of online learning resources (Handley, 2014).

Modes of delivery

When categorising and comparing online professional learning programs, one of the first delineators is the mode of delivery. There are fundamentally three modes: synchronous, asynchronous, or blended. Within each of these modes, professional learning may be facilitated, self-directed or a blend of both.

Asynchronous self-directed

In an asynchronous self-directed mode of learning, participants can learn at their own pace, usually within a given timeframe. Some units have assessment components which need to be completed (sometimes with a minimum score) to get to the next unit. An example of online professional learning delivery through this mode is provided in Case study 1 (Tekkumru-Kisa & Schunn, 2019).

Asynchronous facilitated

Asynchronous facilitated professional learning is a model that has designated facilitators who are responsible for guiding learners through learning content, and stimulating discussion. In this mode, communication can take place at different times (usually through forum posts and blogs) and participants can choose to respond at times that are suitable to them.

Examples of asynchronous facilitated learning include the Reconceptualising Mathematics and Science Teacher Education Programs (ReMSTEP) and Contemporary Science Practice in Schools programs which consist of a website of videos and modules of work about contemporary science with a focus on how scientists practice science. Teachers in this program could apply this knowledge and contextualise the curriculum for their students, modelling practices, experiments and activities based on how scientists do science. Screenshots of the learning modules and materials are shown in Case study 2 (Blom et al., 2019, p. 9).

Synchronous facilitated

Synchronous facilitated professional learning is live – with all participants present and interacting in real time. Most of the time there is a facilitator present to guide the discussions. ‘Teacher presence’ is an often-referenced factor in successful online learning. Student perception of helpful strategies that enhance teacher presence include timely response to questions and timely feedback on assignments (Martin et al., 2018). Examples of this popular form of professional learning online include webinars, consultation and online conferences and workshops. Case study 3 presents an example of live short courses delivered to NASA Explorer schools (Marrero et al., 2010).

Blended

Delivery via any mixture of modes is referred to as a blended mode of delivery. This could include a mix of any of the above modes and the multiple modes are usually selected to support maximum engagement and collaboration among the participants. There are potentially many variations on blended or mixed mode delivery. Case study 4 is just one example of a blended online professional learning program (Hilli, 2020). Another is the CSER Digital Technologies Education MOOC in Case study 5 (Vivian et al., 2014).

Learning management platforms

Program websites are a common way for organisations to make digital professional learning resources available to participants beyond their own institution. The information architecture upon which a website is built is as flexible as the vision and skills of the programmer designing it. In many cases some kind of programming will be required to develop a website that is appropriate for hosting the resources and tools relevant for effective delivery of a professional learning program.

Learning Management Systems are platforms built specifically for online learning, and the many affordances of this are seen in the research that was conducted in formal school or higher education settings. Selection of a learning management platform is a major investment and may not be an appropriate fit for standalone professional learning programs or resources.

Recommendation: Consider the pros and cons of different modes of professional learning, including blended approaches, and determine the learning approach prior to selecting a learning management platform.

Principle 4: Social presence: participants are engaged with content, facilitators and peers

One of the recurring findings about online learning is the value of ‘social presence’. A definition of social presence is the extent to which a person feels ‘socially connected’ to others in their online environment (Oh et al., 2018; Stone & Springer, 2019). In an educational context, there is a specific focus on ‘teacher-presence’, or how the facilitator welcomes participants, connects with them, and communicates throughout the program.

Research across face-to-face, online, and blended learning experiences across different modalities, contexts, and audiences, shows that “for students and instructors alike, one concept has remained the key to a successful experience: the power of human connectedness for learning” (Whiteside et al., 2014). Social presence contributes to participant satisfaction, motivation and retention. It involves personal dimensions such as immediacy, community, interaction, trust and off-topic exchanges. When social presence is low, group dynamics suffers. There is emerging research about whether video interaction contributes better to engagement in learning than text or audio-only communication because it more closely parallels in-person communication.

Provision of learner supports is a common theme in the literature on online professional learning. Salmon’s (2011) five-stage framework shown in Figure 2 is widely used and makes the strong point that before participants can be effective at information exchange, knowledge construction or development, they need to move through the stages of access and motivation, and online socialisation. In order to make these steps they require both technical and facilitator support (p. 11).

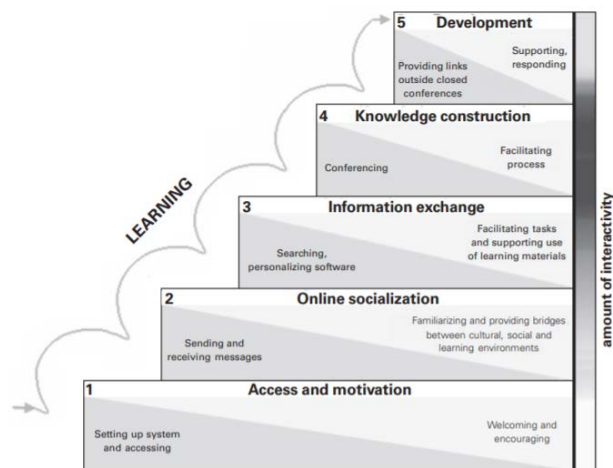


Figure 2 *5-stage model of teaching and learning online through online networking* (Salmon 2011, p. 11 Licence: [CC-by-nc-nd-4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/))

A highly personalised, high-touch form of online professional learning is digital coaching or mentoring. Kraft & Hill (2019) point to the benefits of web-based coaching programs as a form of professional learning that “can be operated at relatively lower costs, are scalable, and make it more feasible to pair teachers with coaches who have expertise in their content area and grade level” (p. 1).

Professional Learning Networks (PLNs) are defined as a system of interpersonal connections and relationships and resources that support information learning (Trust, 2012). These networks provide connections to others worldwide who can offer support, feedback, and collaboration opportunities that allow educators to stay up to date on the latest teaching techniques, pedagogies and practices, and updates in the field of education (Beach, 2012).

Social media is a feature in a number of studies reviewed. Teacher collaboration through social media sites like Twitter, Facebook and YouTube, and LinkedIn are being used as *professional learning networks* to offer ‘just-in-time’ access to information on evolving technologies and allowing teachers to connect globally through social media live features (Jones & Dexter, 2014). A number of studies have reported how the *Twitter* platform in particular has filled the gap in face-to-face professional learning, providing opportunities for educators to share information, knowledge, resources, and classroom experience, as well as to collaborate and reflect with other educators (Ross et al., 2015; Trust, 2012). The possibility of anonymous participation in some of these networks, has allowed teachers the capacity to discuss issues they feel are inappropriate for their school-supported platforms, and a way of seeking support without feeling intimidated (Jones & Dexter, 2014).

One of the MOOC designs reviewed, reportedly overlooked the significance of a sense of belonging and the connectedness among the course participants and did not include explicit steps for building a community. The researchers concluded that the design and organisation (procedures, course content and the scheduled events predefined in the LMS) had been considered more important than facilitation and direct instruction (Krzyszowska, 2020). The tendency to focus on the tangible technology and content building is something to guard against in designing online resources and programs.

Recommendation: Note the importance of social presence for effective online professional learning and identify strategies for incorporating these benefits into the development of resources and programs.

Principle 5: Quality content: using diverse media drawn from reputable sources

Multimedia courseware is a term used in the early research literature for online learning resources or ‘assets. There is natural focus on multimedia in online learning as this is one of the features that the online environment provides that was missing in previous distance education or asynchronous learning. From this research comparing the benefits of multimedia learning resources, over text-only resources, there are findings such as Cowan and Morey (2007) to suggest that individuals learn better from multimedia messages when they are designed in ways that are consistent with how the human mind works. This is supported by the Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2001) which is a theoretical framework that explains how multimedia benefits learners, and also provides design guidelines for the production of educationally effective multimedia materials to reduce cognitive load imposed on working memory.

Evaluating Digital Content for Instructional and Teaching Excellence (EDCITE) was a year-long professional development program focused on supporting teachers in evaluating and selecting educational digital resources (EDRs) (Xie et al., 2018). They identified that educational digital resources can range from “single online videos to interactive websites, from games and apps to adaptive problem sets, from lesson material developed by individual teachers to academic publishers' resources based on state adopted standards.” Each of these formats has distinct features that influence how it might be used in professional learning. Selecting an approach involves considering which approach will best meet the identified professional learning need, what challenges may occur and how can these challenges be managed?

There are several checklists available that provide criteria of quality, providing statements to consider such as:

- Playlists, not packets: give choice in content. Content selection should include diverse media and draw from a variety of sources, academic and otherwise (GOA, 2020)
- Integrity of a resource is a critical component of educational value, requiring the source of a digital resource and/or of its content is reputable, current and accurate (ESA, 2011, p. 2).
- This includes the level of professionalism of media: attractive which should be functional and appropriate for teachers (Cavanaugh & Dawson, 2010).
- Content should be edited, referenced correctly, with no broken links. All content will be clearly licensed and labelled with its provenance and copyright and re-use status (ACER, 2013).

Recommendation: Focus on quality content, using diverse media and drawing from reputable, current and accurate sources, that is correctly referenced and labelled, and is attractive, functional and appropriate for the teacher audience.

3.4 Bringing it all together

The secret to effective online professional learning is to incorporate these principles into a coherent program or resource. One example of a program that has been demonstrated to achieve this is a MOOC (Massive Open Online Course).

A MOOC is “an online course with the option of free and open registration, a publicly shared curriculum, and open-ended outcomes. MOOCs integrate social networking, accessible online resources, and are facilitated by leading practitioners in the field of study” (McAuley et al., 2010, p. 10). MOOCs are structured, usually on a weekly basis, and include learning activities and resources that learners use in a self-directed way. MOOCs that also offer connection with others doing the course, numbering sometimes up to thousands of people, are known as cMOOCs. Another form, known as an xMOOC provides the same content with limited interaction with facilitator or other participants. MOOCs have been recognised as a new form of online learning and professional development in various occupation fields, including for teacher professional development (Koutsodimou & Jimoyiannis, 2015; Laurillard et al., 2018).

Vivian et al. (2014) were commissioned by the Australian Government to develop a MOOC for teachers to support the implementation of the Australian Curriculum Digital Technologies learning area. The design principles of this MOOC included meeting teacher needs whilst allowing for flexibility, ad hoc interactions, support, and the open sharing of resources. The MOOC was supported by expert facilitators and coordinators in each state and territory. It also integrated social media for knowledge exchange and resource building. The MOOC platform once built, was used to support additional professional learning programs as new topics were needed.

Mobile learning researchers also bring together the various components of online teacher professional learning into a holistic solution, and the conceptualisation in Figure 3 provides a helpful map for those designing online professional learning.

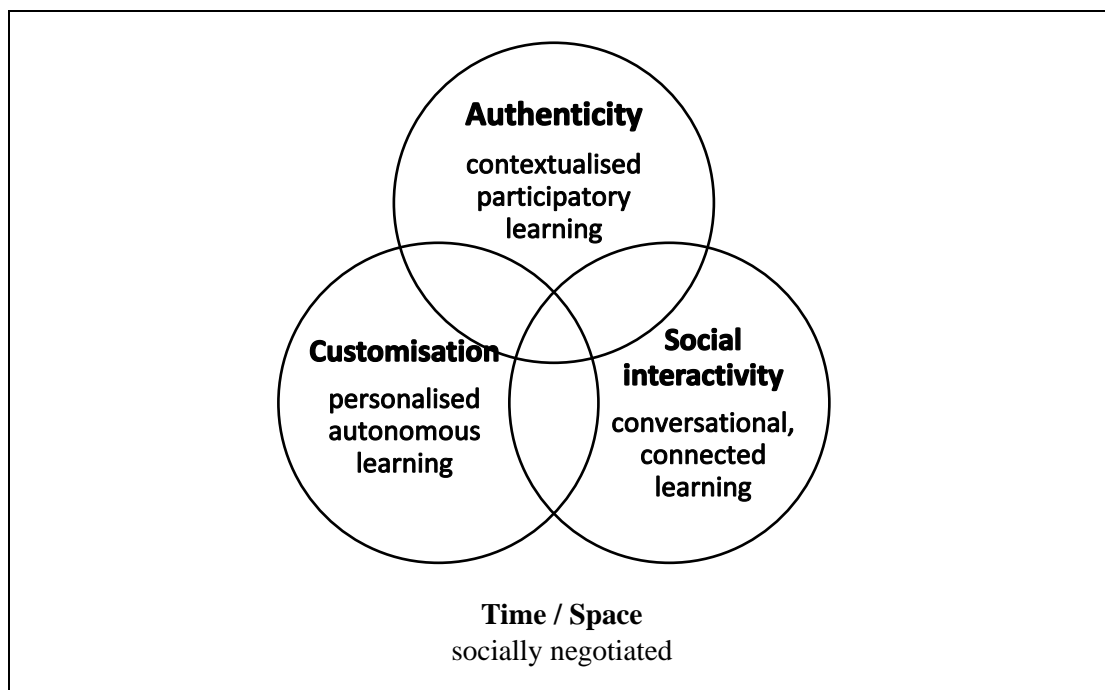


Figure 3 Pedagogical framework for mobile learning presented at mLearn 2010 by Kearney, Schuck & Burden (Kearney et al., 2012).

4. Discussion

This final section summarises the findings and responds to the broad research question:

What does the research evidence say about the design and delivery of digital, online resources for teachers and what practice implications and recommendations could be made based on this research evidence?

Based on these findings, the reviewers synthesised key success factors, recommendations and next steps for Life Education Australia regarding the development of online teachers' resources as part of the Being Healthy Being Active project. The limitations and potential biases in the selection of evidence for synthesis for this current review are also outlined.

4.1 Key success factors contributing to positive learning outcomes

Ultimately the end point of most teacher professional learning is to improve the learning outcomes of the students they are teaching. Making the connection between professional learning activities undertaken by a teacher and improvement in their students' learning is a challenge that researchers continue to face. For reasons discussed at the outset of this report, professional learning is a challenging area to research as it involves so many intersecting factors. However, there is some indicative evidence about the impact of teacher professional learning on student learning.

As referenced in Table 1 of this review, teacher coaching is one form of professional learning where randomised control trials or rigorous quasi experimental methods have been used to evaluate the impact of programs on student outcomes. A recent meta-analysis of 60 studies found that, on average, the programs improved instructional quality by half a standard deviation and student achievement by almost one fifth of a standard deviation (Kraft et al., 2018).

The following key success factors have been identified from the analysis of key design features and elements of the online teacher professional learning interventions included in this review:

1. A blended (mixed modal) design offers the flexibility of asynchronous, synchronous, self-directed learning and facilitated modes.
2. Facilitation that effectively supports an online intervention is valuable, whether to guide consultation and discussion forums or to support the participants with the selection of tools and resources for a particular topic.
3. Technological support as a vital design element recognising that not all participants will have the knowledge and skills to navigate through any specific online platform.
4. Online registration of participants is a useful element to track participation and use of online resources. Such data can also be used to decide on future program directions.
5. The ease of use of an online platform is a key design feature. Complex designs make it harder for participants to navigate through and find the resources/tools that they need. Tutorials or short 'how to' videos are good elements to include, in addition to technical support to troubleshoot hardware requirements and software needs.
6. Short videos on key topics provide 'bite-size' professional development chunks that are less time and resource intensive, and thus convenient for busy educators.

7. Creation of special interest groups for specific topics is a way to bring together those participants with knowledge and expertise on a topic. Such arrangements are more productive than general forum discussions.
8. Participants' feedback to inform platform design and online engagement and learning delivery is valuable and increases ownership and participation.

4.2 Potential barriers

Several potential barriers faced by teachers in realising the benefits of professional learning were identified in the literature and can be summarised as barriers related to:

- Resources: whether problems of subject content, format or technical issues
- Institutional and administrative barriers: such as workload, time factors and priorities in their local context
- Training and experience: prior knowledge, lack of support, irrelevant or confusing information
- Attitudinal barriers: negative perceptions, fear of discomfort, change or failure (Ming et al., 2010, p. 406).

4.3 Implications for practice

This section discusses the implications for the design and delivery of online teacher professional development resources. It directly addresses the three research questions:

1. With regard to online learning platforms for the delivery of resources to teachers: how are these platforms meaningful, engaging and user-friendly?
2. Which modes and formats of online resource delivery are most appropriate to reach teachers, particularly those in rural and remote areas?
3. What modes and formats of online resources could be best used by Life Education Australia for the Being Healthy, Being Active project?

What makes platforms meaningful, engaging and user-friendly?

Drawing from the key findings of this rapid review, Figure 4 represents the key features which are desirable for online teacher professional resources design and delivery. A blend of these features will help to ensure that the teachers find the resources and tools to be meaningful, engaging and user-friendly. The participating teachers are therefore expected to learn better and become more confident in applying their newly acquired knowledge and skills in their classrooms. Section 4.3 provides guidelines for using each of these effective practice features.

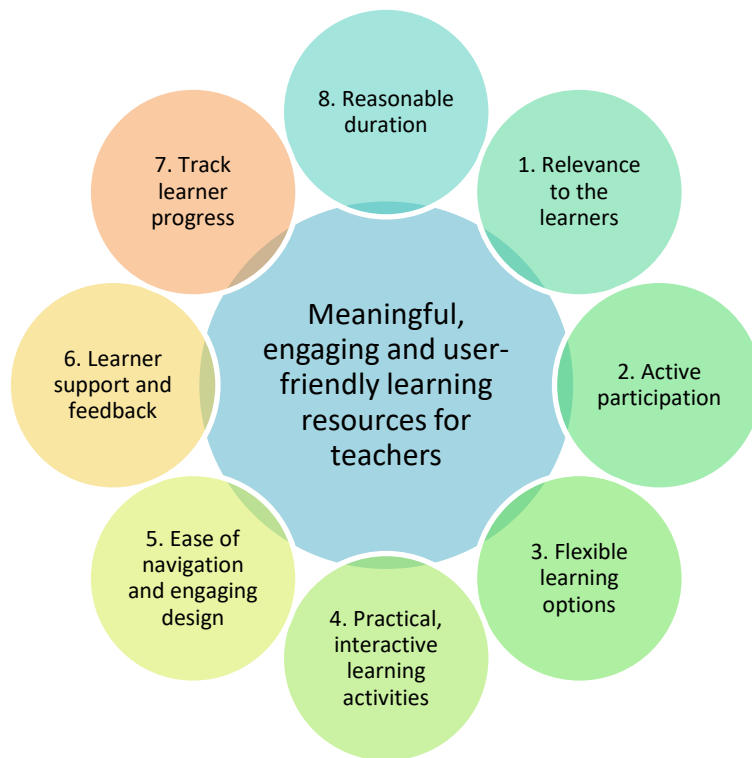


Figure 4. Key features for designing a meaningful, engaging and user-friendly online resources

Which modes and formats of online resource delivery are most appropriate to reach teachers, particularly those in rural and remote areas?

A collaborative online learning environment appears to be positively linked to participants' learning outcomes (Hilli, 2020; Tekkumru-Kisa & Schunn, 2019). The impact of online collaborative learning environments has been seen across all subject areas as well as on general topics such as using ICT or collaborative reasoning as seen in column 6 of Appendix 3. Collaboration also fosters reflective practices and group problem-solving (Bradshaw et al., 2012; Chitanana, 2012; Marrero et al., 2010). However, some training may be required to ensure proper online etiquette, in addition to effective facilitation, which is necessary for nurturing group engagement (Krzyszowska, 2020).

Based on this review there is not enough evidence to suggest synchronous communication is more effective than asynchronous but there are benefits of either approach for different aspects of professional learning. For example, synchronous communication seemed to be more effectively applied across online/ digital coaching and mentoring for teachers (Randolph & Duffy, 2019) yet asynchronous approaches were also helpful for supporting such programs— for example, through asynchronous video feedback that allow teachers to review their own practice (Kraft & Hill, 2019; Allen et al., 2015, 2011; Suk Hwang & Vrongistinos, 2012).

As mentioned above, the use of videos can be particularly helpful to enable teacher-participants to review their own work and reflect on others' actions in the classroom (Kraft & Hill, 2019). However, use of video unaccompanied by other features is unlikely to be effective and therefore needs be paired with other tools and resources, or activities such as role playing and practice or discussion with other professionals (Kraft & Hill, 2019; Hindman et al., 2015)

With regards to remote and rural settings where internet connectivity may not be strong, a combination of blended modes and formats seem to work well. An example of blended program with various formats is provided in Box 1.

Box 1 A blended online coaching program in a remote/ rural context

The iCoaching initiative (Randolph & Duffy, 2019)

The iCoaching initiative comprises of sessions where the coach sends a prompt to remind the participating teacher to deliver the desired behaviour in classroom through a bug-in-ear (BIE) coaching using iPods, Bluetooth earpieces, and the FaceTime application. Overall, the coach provides both support and connections in professional development, implementation, and generalisation.

Requirements:

- The teacher and coach work as a team throughout the process.
- The teacher and coach either attend a PD session on evidence-based practices (EBP), or complete an online training or module focused on the topic.

Benefits:

The technology ensures that teachers receive real-time coaching comments.

Outcomes:

Teachers' pedagogical practices and collaboration and engagement.

As well as rural and remote teachers, AITSL has identified early childhood teachers and casual relief teachers as two other cohorts who are particularly disadvantaged in terms of access to professional learning (AITSL, 2017). Online delivery of high-quality professional learning programs and resources is of particular relevance to these teachers who typically cannot access school-based professional learning.

While the pre-service teacher cohort is out of scope for this review, it is worth noting that this group may be highly motivated to investigate low cost, accessible online resources, and are typically heavy users of the internet with free access provided by their institution (Mansfield et al., 2020).

What modes and formats of online resources could be best utilised by Life Education Australia for the Being Healthy Being Active project?

Section 4.3 addresses the third research question and the overall remit of the review by distilling the review findings into a set of good practice guidelines for the development of online teacher resources. These guidelines address findings that are directly pertinent to Life Education Australia's planned *Being Healthy Being Active* project.

4.4 Effective practice guidelines for development of online teacher resources

In this section, the principles underpinning design of digital resources for teacher professional learning have been linked to the key design features (as depicted in Figure 4) and summarised into a set of good practice guidelines for the development of online teacher resources (in Table 4).

Table 4. Good practice principles summarised

Effective features	Course of action	Pros	Cons
Relevance to learners' needs	<p>Provide a diverse set of resources and tools to match participants' needs and interests on a topic.</p> <p>Provide different formats of resources such as reading materials, presentation slides, videos, podcasts, live webinar, and links to websites/ portals etc. from reputable and current sources to meet the learning needs of a diverse group of learners.</p>	<p>Teachers who experience a more personalised approach to learning, incorporate contemporary technologies and make authentic connections to their practice are more likely try similar approaches with their students (Brooks & Gibson, 2012).</p>	
Active participation	<p>Use online collaborative and networking tools.</p> <p>Introduce special interest groups for key topics.</p> <p>Set up discussion forums that are guided by a skilled facilitator.</p> <p>Use participants' feedback to make upgrades to platforms, intervention design and implementation process.</p>	<p>The collaboration, reflection and engagement help the teacher participants to move from being 'users' to active 'members'.</p> <p>Skilled facilitation that fosters learning oriented community of practice could positively influence the interactions among the participants.</p> <p>Special interest groups and professional networks are often active beyond the project's lifetime.</p> <p>Peer support and collaboration promotes teachers' confidence and creates a favourable learning environment (Nihuka & Voogt, 2012).</p>	<p>A lot of time is often needed for these socialising activities and for building active communities.</p>
Flexible learning options	<p>Offer participants the options for learning synchronously (live), usually facilitated or asynchronously at their own pace (self-directed may include some amount of facilitation).</p>	<p>Caters for learners who prefer to study in their own time as well as those who prefer synchronous/ live learning.</p>	<p>More expensive as need to plan and support multiple modes.</p>
Practical, interactive learning activities	<p>Provide teachers the option to participate in activities that require them to use and apply their professional knowledge and work collaboratively to solve problems related to their practices (Randi & Zeichner, 2004).</p>	<p>Activities that require participants to tap into their professional knowledge and work collaboratively to apply this knowledge for solving problems keeps them engaged and interested in learning.</p>	<p>Highly structured, organizationally orientated PD is costly (Brooks & Gibson, 2012).</p>

Effective features	Course of action	Pros	Cons
Ease of navigation and engaging design	<p>Provide structured, well-planned learning materials that uses interactive and appropriate digital learning resources and tools (video, animations, quizzes and games). The platform also needs to be user-friendly and simple.</p> <p>Use inclusive tools, platforms and devices that consider different web content and accessibility guidelines (e.g., WCAG 2.0) to make the resources useful for a wider range of people, such as people with disabilities (Ferri et al., 2020).</p>	<p>Participants find the resources and tools interesting and are appropriately engaged.</p> <p>Users with varied levels of technical competence or accessibility needs can navigate the platform with ease and are able to find resources effortlessly.</p>	<p>May be more resource intensive and requires research on learners' needs and accessibility requirements.</p>
Learner support and feedback	<p>Provide timely technical support.</p> <p>Include content / instruction support and feedback structures (often managed through the facilitator / course instructor/ module developer).</p>	<p>Support and feedback from facilitators can help teachers to identify their learning needs, and can thus contribute to their knowledge and skill development (Nihuka & Voogt, 2012).</p>	
Tracking learners' progress	<p>Use an online registration system to monitor engagement and progress for various modules.</p> <p>Suggest additional resources and tools upon completion of each topic.</p>	<p>Online registration function enables tracking of participants as they attend courses and events and/or collaborate to access and share resources. Also useful for targeting additional resources.</p>	<p>May be more resource intensive and requires learning management software.</p>
Reasonable duration	<p>Select a feasible duration for the program / intervention.</p>	<p>Lack of time is often identified as a potential barrier to either participation in a PD or program implementation (Philipsen et al., 2019), therefore a reasonable timeframe will be useful to keep the teachers engaged for the entire duration of a program.</p>	

4.5 Limitations of the review

Limitations in the body of research literature

- Only papers published in English language were included in this review, thus some papers from non-English speaking high performing education systems could have been missed.
- Due to the short timeframe only two educational databases were systematically searched supported by some additional searches through snowballing and reference list scanning.

Possible sources of bias in the review of literature

- Studies were included in the final evidence synthesis only if the design and delivery features and elements were noted under the description of the interventions. Thus, some effective programs may have been dropped if there was no focus on program design and delivery approaches.
- Successful design and delivery models for online resources and interventions could also exist in education systems in low-and-middle-income countries, however, due to the nature of this review the screening only focused on interventions in countries and education systems that are comparable to Australia.
- The implications and recommendations for this review are the results of the contextual environment and backgrounds of the reviewers, therefore, we acknowledge that other views and assumptions towards good practice guidelines for online teachers' resource development are likely to be out there which could have been missed.

5. Conclusion

This rapid review identified many aspects related to the design of online professional learning programs and resources. These have been aggregated to produce the following set of overarching design principles and recommendations that apply regardless of the specific audience, format or content of a professional learning activity:

Principle 1: Relevance: meeting teachers' needs

Recommendation: Involve teachers in the design, trialling and evaluation of online professional learning programs and resources to ensure relevance.

Principle 2: Educational value: focusing on learning

Recommendation: Commence development of online professional learning from a strong shared understanding of the learning outcomes and how to effectively assess teachers' learning of those outcomes.

Principle 3: Managed and flexible learning environment

Recommendation: Consider the pros and cons of different modes of professional learning, including blended approaches, and determine the learning approach prior to selecting a learning management platform.

Principle 4: Social presence: participants are engaged with content, facilitator and peers

Recommendation: Note the importance of social presence for effective online professional learning and identify strategies for incorporating these benefits into the development of resources and programs.

Principle 5: Quality content: using diverse media drawn from reputable sources

Recommendation: Focus on quality content, using diverse media and drawing from reputable, current and accurate sources, that is correctly referenced and labelled, and is attractive, functional and appropriate for the teacher audience.

The review proposes that learning designers consider each of these principles and recommendations, and use them to develop a coherent program or resource by involving teachers in the design, trialling and evaluation of online professional learning programs and resources to ensure relevance. Development of online professional learning should begin from a strong shared understanding of the learning outcomes and how to effectively assess teachers' learning of those outcomes. Designers will consider the pros and cons of different modes of professional learning, recognising that social presence is central for effective online professional learning and identifying strategies for incorporating these benefits into the development of resources and programs is a necessary feature.

Additional features identified in this review include tracking learners' performance, active participation, flexibility of choosing learning modes, support for learners and feedback, ease of navigation and engaging design, practical and interactive learning activities, relevance to learners' interest and reasonable duration. These features are expected to support learning designers and program developers of teachers' online resources with their planning, design and delivery decisions. The effective practice guidelines presented in this review are a starting point for designers and developers of teachers' online resources based on key features as identified in the literature that supported this rapid review.

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Case studies

The following five case studies use screenshots to highlight key design elements for online professional learning.

Case study 1: iPlan tool

Study: Tekkumru-Kisa & Schunn, 2019). Screenshots from:

<https://www.tandfonline.com/doi/full/10.1080/1475939X.2019.1595707>

The iPlan tool: A resources and education curriculum materials hub in an online interactive learning platform

Length: four-weeks

Context: USA

Design elements

- Tasks are designed with macro and micro view
- The macro view includes a verbal task description, and helps to situate the task within the larger curriculum

The screenshot shows the iPlan tool interface for the task 'Gecko Breeding Results (Genotype)'. The interface includes a navigation menu on the left with 'TASK C' selected, indicating 2 class periods and 6 discussions. The main content area features a 'Task Description' section, a 'Resources' section with links to PCR data, worksheets, and a design challenge, and a 'Situating this Task into the unit' section. A central diagram illustrates the 'Design Challenge' (Module 4) at the center, surrounded by four models: 'Multi-Gene Model of Inheritance' (Tasks E1-E8), 'One-Gene Model of Inheritance' (Tasks D1-D5), 'Allelic Model of Inheritance' (Task C), and 'Connecting Genotypes to Phenotype' (Tasks F1-F5). The diagram is set against a background of 'Phenotype' (top) and 'Genotype' (bottom). Below the diagram, the text 'Why this Task now?' explains the task's purpose. Further down, there are sections for 'Content Goal' (Biology), 'Practice' (NGSS Science Practice 4: Analyzing and Interpreting Data), and 'Common Core Mathematical Practice 7: Look for and Make Use of Structure'. The bottom section, 'Moving on from here', outlines the next steps for students.

Select Unit ▾ / Task C: Gecko Breeding Results (Genotype)

Task Overview Task Segment

TASK C
2 Class periods
6 Discussions

Gecko Breeding Results (Genotype)

Task Description
Students begin to explore inheritance at the genotype level by examining two contrasting sets of PCR results.

Resources

C.1: PCR Data
<https://files.google.com/site/geckozoomvideo/resource>
http://great.com2jov6ibvgpw7utm_campaign=share&utm_medium=copy&rc=ex0share
Task C Worksheet p1-2.pdf

C.2: Develop Rules of Inheritance
Task C Worksheet p3.pdf

C.3: Summarize Inheritance Rules in Scientific Terms
Task C Worksheet p4.pdf

C.4: Connection to Design Challenge
Task C Worksheet p5.pdf
Breeding Design Worksheet.pdf
Culz 1- after Task C.pdf

Situate this Task into the unit

Why this Task now?
The PCR results invite students to further explore the question from Task B, "How can two similar looking parents have different kinds of offspring?" This task challenges the novice idea that offspring may differ from parents because of chance and builds the foundation for the inheritance model by demonstrating that there are rules governing the way genes are inherited. Students derive the rules of inheritance by identifying patterns in the PCR data and generating rules to describe those patterns.

Content Goal
Biology

- The basic allelic rules of inheritance include the following:
 - Each organism has two versions (alleles) of each gene.
 - One version of each gene comes from the male parent and one comes from the female parent.
 - Offspring can only get what the parents have to give.
 - Scientists use specific terminology to communicate about inheritance (e.g., alleles, genes, chromosomes, DNA).
 - There are different levels within an organism.
 - PCR data represents information about an organism at the DNA level.

Practice
NGSS Science Practice 4: Analyzing and Interpreting Data
"A major practice of scientists is to organize and interpret data through tabulating, graphing, or statistical analysis. Such analysis can bring out the meaning of data—and their relevance—so that they may be used as evidence." (NGSS, 2013)

Students will analyze and interpret data by

- observing PCR results of two different gecko matings,
- comparing and contrasting the results to make sense of the two matings, and
- interpreting the PCR data to derive rules of inheritance.

Common Core Mathematical Practice 7: Look for and Make Use of Structure
"Mathematically proficient students look closely to discern a pattern or structure."
In developing their inheritance rules, students will:

- recognize that there is a predictable pattern in the data, and
- generate rules to describe the pattern.

Moving on from here
In Task C, students derive the inheritance rules by describing the inheritance patterns they see in the PCR data. They can now refine their ideas about inheritance to include a reliable description for what offspring will inherit from parents (one allele from each parent and only what the parents can give) and what genetic information each organism should have (two alleles). Students can also refine their initial breeding designs to emphasize gecko genes as well as gecko traits. Three questions relevant to their design challenge work emerge:

- How do the inheritance rules connect to the biological mechanism of gecko offspring generation?
- How can we predict what offspring a particular set of gecko parents might produce?
- How are gecko appearances connected to gecko genotypes?

Source: Tekkumru-Kisa & Schunn, 2019; p 140

The micro view includes many practical details, such as amount of time, class grouping (i.e. whole class, small group or individual work) and even particular questions that could be asked of students

Guiding Students to Consensus: Whole Class [10 min]

Purpose: To enable students to agree on a list of PCR observations that they will use to develop rules of inheritance in Segment C.2.

- Teacher asks students for observations.
- Class decides whether each contribution is an observation or inference.
- Teacher records the observations on chart paper for use in generating the rules of inheritance.

Monitoring Student Thinking: Small Groups [10 min]

Purpose: To use data to refine ideas about inheritance.

- Teacher hands out page 2 of Task B Worksheet.
- Student groups examine mating results and write responses to worksheet questions.
- Teacher gets ready for whole-class discussion by monitoring how students explain the mating results and noting unwarranted assumptions students make about the data. For example, students may claim that, in the first mating, half the offspring are normal and half are blizzard. There is no evidence in the pictures to indicate quantity.

Important

Monitoring for ideas during group work can help you structure the class discussion to maximize student-to-student interaction. For example, try to identify groups with contrasting wrong ideas (see examples below). During the discussion, invite those groups to share and encourage the class to ask questions and offer feedback.

Sample Student Responses	Category of Student Idea
"All the normal offspring are girls and the boys are rare because they are blizzards."	Offspring will look like the parent of the same gender.
"In the second cross, the blizzard was worn out. The normal Female 2's genes became more dominant."	A parent's ability to transfer features or the strength of the features themselves are weakened with repeated matings.

Guiding Students to Consensus: Whole Class [20 min]

Purpose: To reach a consensus that there must be hidden factors within the parents that account for the mating results.

- Teacher invites groups to share their answers.
- Students ask questions and decide whether they agree or disagree with each group's interpretation or explanation of the data.
- Teacher charts student ideas about the mating results and, as necessary, guides students to focus on the data and whether or not it supports their ideas.
- Students compare charted ideas and develop consensus on how to explain the data.

Target

Students should recognize the following:

- Parents that look the same do not always produce the same offspring.
- Offspring appearance cannot always be predicted based only on parental appearances.
- There must be hidden factors within the parents that determine what kinds of offspring they produce.

Source: Tekkumru-Kisa & Schunn, 2019; p 142

- Other useful functional features include the 'target icon' to help teachers understand how much conceptual progress students may require on a topic.
- The 'important icon' provided links to supplemental information.

Outcomes:

Teachers' pedagogical practices; collaboration and engagement; and Pedagogical Content Knowledge (PCK)




Learning points

A skilled facilitation could change the interactions about the participants.

Case study 2: Reconceptualising Mathematics and Science Teacher Education Programs (ReMSTEP)

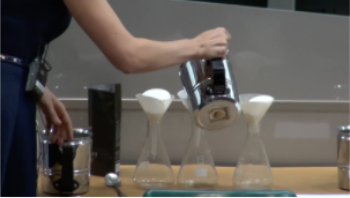
Study: Blom et al., 2019. Screenshots from <http://remstep.org.au/outcomes/resources> Licence: [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/)

Reconceptualising Mathematics and Science Teacher Education Programs (ReMSTEP)
Context: Australia



Home About the project **Outcomes** In the news Conference

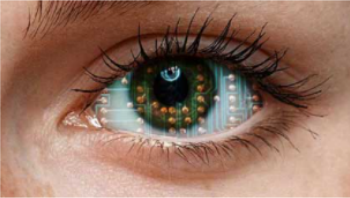
Activities Resources



Scientists as Partners in Education Seminars

ReMSTEP at La Trobe recorded a series of seminars in which scientists described their research and practice and demonstrated an activity that teachers can easily do in their own classroom.

[Watch these videos >](#)



Bionic Eye Teaching Sequence

A collaboration between Master of Teaching students at Deakin University, The University of Melbourne, and scientists from the Gene Technology Access Centre produced Units of Work and Resources which are aligned with the Victorian Curriculum and Assessment Authority VCE Biology Curriculum.

[Explore this resource >](#)

Bionic Eye Teaching Sequence

for maths/science level 9 of the Australian Curriculum

Home **Module 1** Module 2 Module 3 Module 4 Summative task

Bionic eye module 1

Overview

Australian Curriculum links

Learning sequence

Learning sequence

Download the resource pack for this module: [Bionic-eye-module1.zip \(6.2MB\)](#) ↓

Learning activities summary

More details are contained within the detail design document in the resource pack above.

Part 1 5-10 min

Quiz

Teacher activity

Disseminate quiz for students to assess misconceptions they have about light and seeing.

Monitor student responses.

Teacher resources

- Teacher notes / **00-Traffic-Lights.docx**

Student activity

Students work through a quiz, which identifies their misconceptions around light and seeing.

Resources required

- Student-Worksheets / **01-Quiz.docx**

Part 2 5-10 min (30 minutes at home)

'Mythbusters' flipped classroom activity

Teacher activity

Give students feedback on the quiz in the form of investigations to undertake to disprove identified misconceptions.

Student activity

Students work through guided investigations which seek to disprove their misconceptions (at home).

Case study 3: NASA Explorer schools

Study: Marrero et al., 2010. An example of short-live courses

Live, Short-Courses for NASA Explorer Schools

Multimedia courseware

Length: Short

Context: USA (Grades 4-9 Science teachers)

Design elements

- This intervention included seven short-courses that were live online courses each comprising 4-6 one-hour sessions, with some independent assignments as follow-up activities between the sessions.
- Teachers participated simultaneously logging into an online classroom and using a telephone to dial into a conference call.
- The interactive atmosphere of the short course provided an opportunity to ask and answer questions aloud and to share unique, personal experiences.
- Instructors for the courses used embedded technological resources, such as online quizzes/polls, as a formative assessment and as a way for participants to share ideas quickly.
- Other distance learning opportunities were also additionally offered for e.g., one-session webinars and events through NASA's DLN, a videoconferencing tool.

Outcomes

Teachers' pedagogical practices; collaboration and engagement; and Pedagogical Content Knowledge (PCK)

Learning points

Participants had issues with the technology during the session since technological support was not provided during the program—reported as a design and implementation flaw.

The live format worked well for teacher professional development in science education since the content was challenging and this design allowed participants to ask and receive answers in real time and eliminated some of the frustrations that may be the result of learning difficult content.

Case study 4: Virtual Learning Environments

Study: Hilli, 2020. An example of blended mode

Virtual Learning Environments (VLEs)
Electronic learning management systems
Length: 1.5 years
Context: Finland (rural primary schools)

Design elements

- It combined social media and Learning Management Systems (LMS) and also comprised of assessment practices and tools.
- The elements were a combination of virtual group discussions, interviews, and video blogs.
- In virtual group discussions the facilitator engaged the teachers to address questions, concerns, successes and their professional reflections.
- The interviews were semi-structured lasting around forty-five to sixty minutes and the individual interviews offered opportunities to confidentially critique the project and therefore were helpful for making adjustments along the way.
- The video blog was a reflective and individual space for the teachers and offered ‘snapshots’ from a complex practice.
- It supported their professional development and reduced the teachers’ professional isolation.

Outcomes

Teachers’ pedagogical practices; attitudes and beliefs; collaboration and engagement

Learning points

Digital competence of the teachers and digital infrastructure present at their schools are important for extending classrooms into a virtual space.

VLEs can sometimes constrain teaching practices by only offering certain tools for assessment.

Case study 5: CSER Digital Technologies Education MOOC

Study: Vivian et al., 2014. Source: CSER MOOC (University of Adelaide)
<https://csermoocs.adelaide.edu.au/resources> Licence: [CC-BY-NC-SA 4.0](#)

The screenshot shows the 'Resources' page of the CSER MOOC. At the top, it identifies the course as 'CSER MOOC (University of Adelaide)' with the context 'Australia'. The main heading is 'CSER DIGITAL TECHNOLOGIES EDUCATION'. Below this, the breadcrumb 'home / Resources' and a 'Login' link are visible. The section is titled 'RESOURCES' and contains an introductory paragraph: 'There are many available resources to support you in learning more about Digital Technologies.' This is followed by another paragraph: 'Here we have included information on some of the resources that we have created, as well as information on local clubs, associations and competitions that will be able to support you and your classroom.' An 'Expand' link is located to the right of this paragraph. Below the text are four expandable menu items, each with a downward arrow: 'CSER webinars and videos', 'Resources for Teachers', 'Professional Learning Resources for Leadership & Facilitators', and 'Resources to Support Parents and Families'.

CSER MOOC (University of Adelaide)
Context: Australia

CSER DIGITAL TECHNOLOGIES EDUCATION

home / Resources [Login](#)

RESOURCES

There are many available resources to support you in learning more about Digital Technologies.

Here we have included information on some of the resources that we have created, as well as information on local clubs, associations and competitions that will be able to support you and your classroom. [Expand](#)

- CSER webinars and videos
- Resources for Teachers
- Professional Learning Resources for Leadership & Facilitators
- Resources to Support Parents and Families



We have a range of professional learning resources to help you deliver in-school or community-based professional learning sessions for the topics below. This includes quick reference guides and PL-in-a-Box (professional learning packs with slides and speaker notes). You are welcome to freely download and customise our resources to suit your needs.

[Professional Learning Guide](#) - A get-started resource with information about our programs and resources and how you can use them to support professional learning in your school and community, face-to-face or virtually.

AI and Emerging Technologies (AR, VR) Resources

- AI and Emerging Technologies [Quick Guide](#)
- AI, AR, VR Classroom Usage [Guide](#)
- [PL-in-a-Box: Introduction to Emerging Technologies](#)
- [PL-in-a-Box: Artificial Intelligence](#)
- [PL-in-a-Box: Augmented Reality](#)
- [PL-in-a-Box: Virtual Reality](#)
- [AR Activity Ideas](#) Handout
- [AI Activity Ideas](#) Handout

Cybersecurity & Awareness Resources

We have the following PL-in-a-Box packs for download that include a series of workshop slides that can be used to run professional learning sessions alongside our Cyber Security & Awareness MOOC. You can run each unit as an individual session or combine and customise slides to suit your needs. We recommend running this alongside participation in our MOOCs so that teachers can engage with our [MOOC community](#) network who are sharing resources and ideas.

Appendices

Appendices are published separately as additional files at:
https://research.acer.edu.au/well_being/20