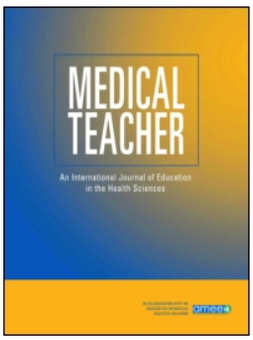

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Instructional media selection principles for online medical education and emerging models for the new normal

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ABSTRACT

The COVID-19 pandemic, and the resulting need to avoid in-person classes, compelled many faculty members to convert to a completely online instructional format. The literature on selecting media for medical educators, however, provided little assistance for them to make choices that facilitated learning through using alternative online instruction practices. In this study, we addressed the lack of guidance for the use of media to facilitate the effective online medical education. To optimise the transition from face-to-face educational modalities to online learning, we incorporated insights from theories of media synchronicity and learning. We considered the value of existing learning theories in influencing how we could guide entrenched face-to-face educators to online learning practice. Therefore, we employed existing theories and practice to assist in developing an algorithmic approach to guiding these educators. We reassessed the way taxonomies of learning objectives, practice-oriented learning experiences, the social and collaborative features of learning activities, and media synchronicity theory could have augmented face-to-face teaching, and influenced how these could be reconfigured to assist in the transition to online learning. Consequently, we have developed key principles to inform the continuity of design and selection of instructional media in the transition to medical online learning. We have constructed specific criteria for media selection that correspond to the 12 goals of medical learning. We found that the majority of the goals can be more enhanced by synchronous media than asynchronous versions. We discuss the role of instructional media in emergency online medical education as well as emerging models of media selection for the new normal in medical education and future directions for medical education media research.

KEYWORDS

Instructional media; media selection principles; media synchronicity; online medical education; new normal learning models

1. Introduction

The COVID-19 pandemic has significantly disrupted medical education creating a greater need for online educational innovations (Grafton-Clarke et al. 2022). Physical distancing protocols prevented students from entering hospitals for their clinical learning activities (Compton et al. 2020). Most medical schools rapidly shifted courses to the online learning environment, requiring further educational, technological, and cultural adaption from faculty. Even though there is increasing acceptance of the endemic COVID-19 paradigm across the world, online instruction has become a new normal in medical education. This approach has led educators to rethink the way online medical education is conducted (Rajab et al. 2020). Such considerations go beyond emergency online medical education i.e. *inevitably delivering an online medical education curriculum during an emergency* situation *without proper preparation* (Taha et al. 2020); they involve the creation of well-planned, carefully designed, high-quality online instruction (Hodges et al. 2020). Accordingly, medical educators and institutions are seeking to improve the quality of online education and identify effective strategies for teaching students online (Kaur et al. 2021). Such efforts will have future relevance, as online medical education is expected to continue in the post-crisis COVID-19 era (Gaur et al. 2020).

Practice points

- Use key principles to inform the continuity of design and selection of instructional media in the transition to medical online learning.
- Use appropriate media that meet the 12 learning objectives for effective medical education.
- Consider the type of media synchronicity to provide the greatest learning affordance.
- Provide a fully online flipped learning to blend pre-class media for conveyance with in-class online asynchronous media for convergence.

Online teaching encompasses a variety of pedagogies, modalities, media, and technologies (Kebritchi et al. 2017; Scherer et al. 2021). One of the most critical decisions faculty members must make when designing and teaching online courses is the choice of instructional media (Heinich et al. 2002; Mishra and Koehler 2006; Bower 2008). Frequently, however, faculty members choose media based

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on convenience or familiarity rather than an understanding of which instructional media would most optimally facilitate learning.

Instructional media selection is an important topic of inquiry in the fields of educational technology and medical education, though most theories and models are premised on traditional in-person or blended learning that do not account for the multifocal intricacy of training medical professionals. Currently, the medical education literature lacks specific knowledge for engaging online medical education (Rizvi et al. 2021; Petichakis 2022). Particularly within the context of emergency online instruction, such as that required by the COVID-19 pandemic, medical educators can benefit from research-based guidance when selecting the best media platform. In this study, we propose a set of instructional media selection principles when selecting online medical education, as well as criteria for instructional media selection that correspond to the major goals of medical learning. In addition, we explore emerging models geared for the new normal in medical education.

2. Media synchronicity theory and media affordances

2.1. Media synchronicity theory

Media synchronicity theory (MST) holds that the fit between *information processing needs and media's ability to support synchronicity* leads to better communication performance (Dennis et al. 2008). MST classifies communication media as synchronous (coinciding) or asynchronous (chronologically misplaced). Synchronous media enables all participants to work together and communicate at the same time with a common focus (e.g. through a video conference or teleconference). Conversely, asynchronous media allows participants to communicate at their own pace in their available time (e.g. discussion boards, emails, and voicemails).

MST views communication as a series of tasks that aim to achieve a shared understanding. Within each task, there are two components that must be considered: cognitive processing and communication needs. Cognitive processing consists of *conveyance* and *convergence*, while communication needs focusses on *information transmission* and *information processing*. Conveyance involves transmitting and receiving large amounts of new information (information transmission). Receivers are expected to understand the meaning of the information and build personal mental models about that information at their own pace (information processing). Convergence involves verifying, adjusting, or negotiating others' mental models for shared understanding (information processing) about a brief summary of pre-processed information during conveyance (information transmission). Without proper conveyance, individual participants may fail to construct functional mental models, and without proper convergence, group participants fail to share an understanding that enables them to move forward (Dennis et al. 2008).

The main proposition of MST is that effective convergence requires high media synchronicity, whereas conveyance requires less media synchronicity and is well served by asynchronous media. In addition, unfamiliar tasks, participants, and technology require more synchronous media (Dennis et al. 2008). Ultimately, MST posits that a combined and balanced use of media synchronicity and asynchronicity results in better communication performance.

2.3. Features of online learning media

In response to the COVID-19 pandemic, learning systems and infrastructure had to be quickly created or adapted for course delivery. Emergency remote learning contexts required universal access and delivery, as well as effective instructional media that could facilitate meaningful interactions among learners and instructors through learning resources. A national post-pandemic survey of 39 UK medical schools found that schools utilised a mix of learning media including online live classes, pre-recorded lecture videos, and reading materials (Dost et al. 2020). The dominant trend around the world, however, was to employ *pre-recorded lecture videos* delivered through learning management systems, *online live classes* delivered through online conferencing systems, such as Zoom, Google Meet, or a combination of the two (Lockee 2021). Pre-recorded lectures allow students to learn at their own time and pace, with space for reflection and digestion, which was more frequently implemented in the early stage of the pandemic (Dost et al. 2020). Live online classes allow students to join from any location, interact with other participants in real-time, and reach shared understandings through interactive learning experiences (Bower 2008; Lockee 2021).

The differentiating feature between the two dominant modes of emergency remote learning media is *synchronicity* – the ability of media to support synchronous interaction with a common focus. Studies have claimed that media synchronicity is a critical feature of instructional media with a distinct influence on learning. Wang et al. (2020) demonstrated that three versions of instructional media (interactive, video, and text) were significantly associated with behavioural learning patterns, cognitive load, and knowledge retention (Wang et al. 2020). Synchronous media and asynchronous media benefit learners in particular ways. Synchronous media enables real-time interaction, effectively support collaborative learning activities, increase student engagement, and learning outcomes with medical students (Schullo et al. 2007; Dost et al. 2020). On the other hand, the instantaneous nature of synchronous interaction can hinder reflection and individual mental modelling when compared to its asynchronous counterpart (Branon and Essex 2001; Chen et al. 2009; Hou and Wu 2011). Guidance on when and how to choose a particular learning media, while considering the level of synchronicity, can be crucial to providing meaningful emergency online medical education.

3. Learning theories and unique aspects of medical education

We considered the unique aspects of medical education in reference to three concepts from three learning theories: higher orderness of cognitive *learning objectives* (Bloom 1956; Anderson et al. 2001); the concreteness of *learning experiences* (Dale 1969; Prince and Boshuizen 2004; Loftus 2015); and the social and collaborative features of *learning*

activities (Vygotsky 1978; Schmidtke and Cummings 2017). Bloom's taxonomy and Dale's cone of experience include hierarchal components that align with the difficulty of the learning experience. In other words, as the concreteness of the experience increases, more advanced learning objective can be implemented. For example, direct experiences allow the educator to require students to evaluate and analyse the experience. Whereas lower level experiences such as picture/visual media require students to remember or understand the information. This type of coordination of objectives and experiences inform the educator about the type of interaction the students should engage in and the most appropriate method of delivery for the task. These three concepts can be used to capture diverse and unique features of medical education in terms of learning objectives, learning experiences, and learning activities, which can be ultimately used to develop criteria for media selection in online medical education.

3.1. Higher orderness of cognitive learning objectives

Medical education requires mastery of lower to higher order *cognitive learning objectives* that extend across the entire hierarchy of educational objectives. Thus, the goals of medical education range from lowest-order learning (e.g. recognising and recalling facts) to highest-order learning (e.g. generating new ideas by combining facts). Medical clinical reasoning involves complex cognitive strategies in which clinicians must integrate extensive clinical and biomedical knowledge as evidence for diagnosis and decision making (Patel et al. 2005). Thus, medical students must be able to *remember* scientific and clinical facts, rules, concepts, and ideas; *understand* what they mean and their implications; *apply* them in clinical contexts; *analyse* their parts while recognising the relationship among them; *evaluate* or justify their values in a clinical context; and *create* an integrated clinical solution combining pieces of facts and knowledge.

Cognitive learning objectives can inform media selection criteria for emergency online medical education. In the taxonomy of cognitive objectives identified first by Bloom (1956) and revised by Anderson et al. (2001), the lowest-order to highest-order cognitive objectives are *remembering*, *understanding*, *applying*, *analysing*, *evaluating*, and *creating*. In online medical education, a lower order learning objective – such as remembering scientific and clinical facts, rules, concepts and ideas, understanding what those mean, or simply applying those in a less authentic context – can be better implemented with asynchronous media like pre-recorded video lectures. Conversely, a higher order objective – such as *applying* learned facts and understanding their application in a clinical context, *analysing* and separating facts into parts while recognising the relationship among them, *evaluating* or *justifying* the values in a clinical context, or *creating* an integrated clinical solution combining pieces of facts and knowledge – can be better implemented with synchronous media like online live classes, which likely promotes optimal synchronous interaction between teachers and students thus solving problems in a timely, consensual, and effective manner.

3.2. The concreteness of learning experiences

In medical education, the *concreteness of learning experiences* exists along a continuum ranging from practical knowledge and skills to abstract knowledge and principles (Prince and Boshuizen 2004; Loftus 2015). For example, the pre-clinical phase is aimed at the acquisition of basic and biomedical scientific knowledge through highly abstract learning experiences like learning with textual materials; whereas, the clinical phase shifts to applying acquired knowledge and skills to real world problem-solving in concrete learning experiences like clerkship rotations in hospitals and community settings.

The concreteness of learning experiences can thus inform media selection criteria for online medical education. Dale's classic cone of experience is useful for ordering the degree to which instructional audio-visual materials reflect the concepts of abstract and concreteness (Dale 1969). The eleven components of the cone of experience range from the most abstract to the most concrete: verbal symbols, visual symbols, recordings, radio, or still pictures, motion pictures, educational television, exhibits, study trips, demonstrations, dramatised experiences, contrived experiences, and direct purposeful experiences (Dale 1969). The most abstract experiences, such as listening or reading symbols (*symbolic experiences*) often correspond with auditory or visual processing *(learning through abstractions*). Less abstract experiences, such as watching motion pictures or educational television (*iconic experiences)* lead to integrated audio and visual processing (*learning through observations*). The most concrete experiences involve contrived or purposeful experiences (*direct purposeful experiences)* during which information gathered from lower abstractions is delivered through kinaesthetic actions (*learning by doing*). In relation to media selection, symbolic or iconic learning experiences such as learning with audio, visual, and text motion media or watching demonstrations, which tend to be abstract, rely more on conveyance, and thus, can be more effectively supported by asynchronous media. Conversely, direct purposeful learning experiences such as simulated, dramatised, contrived, or direct-purposeful field experiences, which are more concrete, rely more on convergence, and thus can be more effectively supported by synchronous media.

3.3. Social and collaborative features of learning activities

Once educators determine the learning objectives and the concreteness of experiences, the type of collaboration must be assessed. Medical students need to be capable of both self-regulated learning and group learning, as they need to become independent professionals and medical team members who collaborate with colleagues and multi-professional staff (Barr and Gray 2013). On an intrapersonal level, students engage in self-regulated learning through inner speech that enables them to receive a large volume of new information, try to understand its meaning, connect it to existing knowledge, and build mental models of the conveyed information at their own pace (Vygotsky 1978). During group learning, that is, socially constructed learning (Clark 2009) through interpersonal communication

(Vygotsky 1978), students verify, adjust, or negotiate with others to establish shared mental models that help them cope with conflicts, accept different perspectives, and revise their own mental models, integrating their observations into final decisions (Lave and Wenger 1991; Dennis et al. 2008).

In online medical education, the social and collaborative features of learning activities are an important consideration for media selection. Vygotsky's (1978) sociocultural theory identified two types of communication: intrapersonal communication and interpersonal communication. Intrapersonal communication involves inner speech, making the learning engagement a communication and interactive process that happens within an individual (Saville-Troike 2005). Individuals who are reading, for example, experience the interplay of decoding the written format and using their own schematic understandings to decipher that meaning, a process that enables learning through internal reflection on meaning (Ellis 1999). Conversely, interpersonal communication involves social interaction between two or more people (Saville-Troike 2005). In this case, the process of learning happens within a zone of proximal development, the place between what learners can do or know on their own and where assistance is needed from another person with more knowledge (Vygotsky 1978).

These intrapersonal and interpersonal communication and learning strategies coordinate well with the media affordances of asynchronous media and synchronous media. Asynchronous media allows individuals the freedom to learn anytime and anywhere through media such as utilising a learning management system or pre-recorded video lectures (Griffiths and Graham 2010). While asynchronous media better supports conveyance for individual mental modelling, synchronous media occurs in real time and requires two or more people to interact during the course (Khan 2007), thus better supporting convergence for shared mental modelling. Asynchronous media allows for more intrapersonal communication, while synchronous media provides more interpersonal communication between learners (Schmidtke and Cummings 2017).

4. Theoretical guidance for media selection in medical education

Based on the theoretical foundations we have reviewed, we suggest guidelines to enhance media selection decisions in online medical education.

4.1. Criteria for media selection in medical education

Figure 1 coordinates theoretical insights from the three different learning theories we considered with the type of media synchronicity that provides the greatest learning affordance.

4.2. Media selection principles

The media selection principles in Table 1 are drawn from a synthesis of theoretical insights and practical findings related to media selection for medical education. They are designed to help medical educators make prudent decisions when selecting instructional media.

5. Practical guidance for media selection in medical education

Snell et al. (2019) classified 12 goals of medical learning and suggested optimal teaching methods for each. We sorted these goals according to theoretical considerations about the higher ordered nature of learning objectives, the concreteness of the learning experience; and social and collaborative features of the learning activities, and then associated each with media optimal methods for medical learning. Table 2 integrates various goals of medical

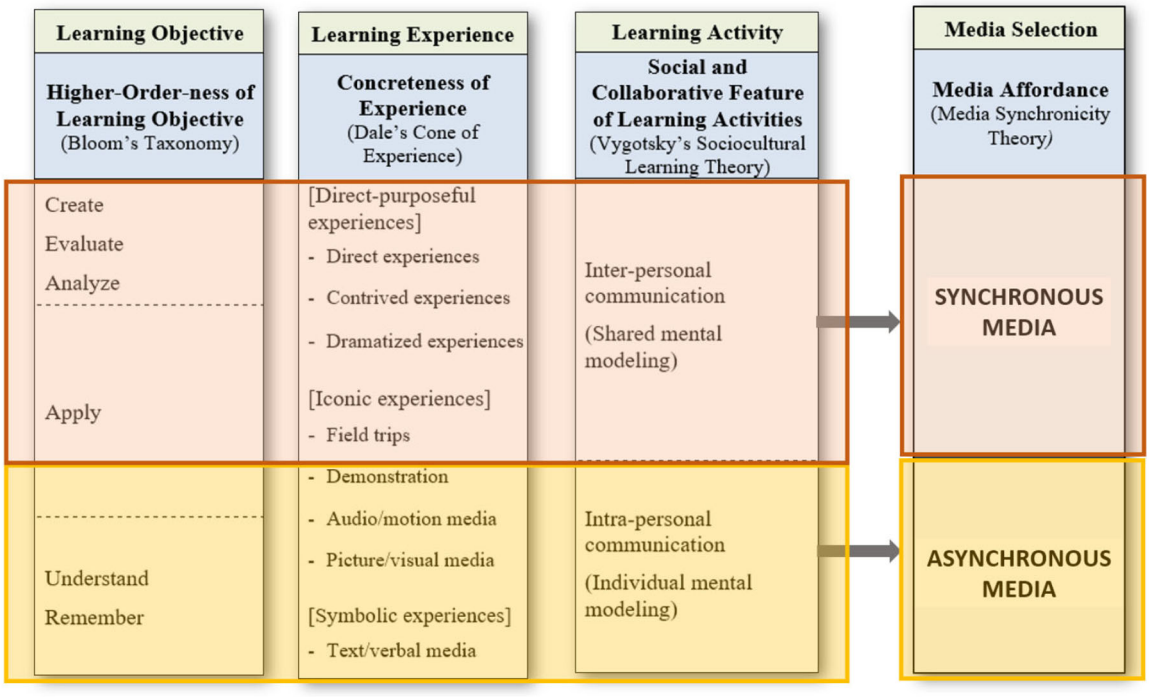

Figure 1. Media selection criteria and supporting theories.

Table 1. Media selection principles.

1. [Relationship between **cognitive process** and **information need**] Each unit of a course should have a set of learning objectives, experiences, and activities that require a different balance of cognitive processes: conveyance and convergence processes.
   - 1.1. In both conveyance and convergence, students engage in information transmission and information processing.
   - 1.2. **Conveyance** mainly requires transmitting and receiving learning content (**information transmission**), followed by helping learners learn the content and build their mental models at their own pace (information processing).
   - 1.3. **Convergence** mainly requires verifying and adjusting learners' mental models for shared understanding (**information processing**) after providing a brief summary of preprocessed content (information transmission).

2. [Relationship between **cognitive process** and **optimal media**] Instructional media should be selected according to the weight of conveyance and convergence needed.
   - 2.1. **Conveyance** processes are more effectively supported by **asynchronous media**. Synchronous media for conveyance may interfere with learners' deliberation.
   - 2.2. **Convergence** processes are more effectively supported by **synchronous media**. Asynchronous media for convergence may delay rapid development of shared understanding.

3. [Relationship between different types of **learning objectives, experiences**, and **activities** and **cognitive process**] Different types of learning objectives, experiences, and activities should correspond to particular balances of conveyance and convergence.
   - 3.1. **Higher order learning objectives** (e.g. creating, evaluating, analysing, or complex applying) involve more **convergence**, whereas lower order objectives (e.g. remembering, understanding, or simple applying) involve more conveyance.
   - 3.2. **More concrete learning experiences** (e.g. direct-purposeful experiences, contrived experiences, dramatised experiences, or field trips) involve more **convergence**, whereas more abstract learning experiences (e.g. demonstration, or learning with audio, visual, and text motion media) involve more conveyance.
   - 3.3. **More social and collaborative learning activities** for shared mental modelling involve more **convergence**, whereas more solitary learning activities for individual mental modelling involve more conveyance.

4. [Relationship between different types of **learning objectives, experiences**, and **activities** and **optimal media**] Instructional media should be selected according to particular features of learning objectives, experiences, and activities.
   - 4.1. **Higher order learning objectives** are more effectively supported by **synchronous media**, while lower order objectives are more effectively supported by asynchronous media.
   - 4.2. **More concrete learning experiences** are more effectively supported by **synchronous media**, while more abstract learning experiences are more effectively supported by asynchronous media.
   - 4.3. **More social and collaborative learning activities** are more effectively supported by **synchronous media**, while more solitary learning activities are more effectively supported by asynchronous media.

5. [Relationship between **a required cognitive process** and **instructional support**] Instructional support should be designed according to the required cognitive process.
   - 5.1. For **information transmission through conveyance**, it is optimal to provide high-quality learning content with multiple formats and sources.
   - 5.2. For **information processing through conveyance**, it is optimal to provide enough time for learners to learn the content at their own pace and for assignments or questions to reflect their understandings.
   - 5.3. For **information transmission through convergence**, it is optimal to provide a short lecture summarising the pre-processed content with specific format.
   - 5.4. For **information processing through convergence**, it is optimal to provide interactive discussion or activities designed to enable learners to verify and adjust their understandings.

6. A unit and a task should be composed of a balanced combination of conveyance and convergence, supported by the appropriate combination of synchronous and asynchronous media.

learning and theoretical frames to create a set of criteria for the optimal use of instructional media in online medical education. Each of learning goals are aligned with optimal learning objectives, learning experience, and learning activities to reach the goal, which are then aligned with suggested media.

6. Discussion and conclusion

We began with a practical need to help medical educators who sought to provide effective medical education during the COVID-19 pandemic crisis, and who may be faced with similar crises in the future. With the particular features of medical education and the online learning environment in mind, we developed media selection principles for emergency online medical education. Given that online medical education may continue for some time, these principles and criteria for media selection may continue to prove highly relevant as 'new normal' models of medical education emerge.

The unprecedented progress of instructional media over the last decades and subsequent changes in the educational landscape illustrate the crucial role of instructional media in learning in our time. The criticality of learning media has been heralded and required during the pandemic, where face-to-face classes and hands-on training were prohibited. Therefore, instructional media served as a vital bridge to maintain the education nexus between learners and educators.

6.1. The role of media in online medical education

We propose that the feature of synchronicity is critical to consider when choosing instructional media for online medical education. Educators must consider how to balance conveyance and convergence strategies based on their learning objectives, experiences, and activities. Higher order learning objectives, more concrete learning experiences, and more social and collaborative learning activities involve more convergence, whereby convergence processes are more effectively supported by synchronous media. Asynchronous media for convergence may delay rapid development of shared understanding. In contrast, lower order objectives, more abstract learning experiences, and more solitary learning activities involve more conveyance, and convergence processes are more effectively supported by synchronous media. Asynchronous media for

Table 2. Goals of medical learning and optimal instructional media.

Goal of medical learning	Learning objective (higher orderness)	Learning experience (concreteness)	Learning activities (social and collaborative feature)	Suggested media
1. Acquire basic biomedical and clinical knowledge	Remember and understand	Symbolic experience	Intrapersonal communication	**ASYNCHRONOUS** lecture/reading + (SYNCHRONOUS Q&A)
2. Obtain information from patient (history taking and physical exam skills)	Apply and analyse	Direct purposeful experience	Interpersonal communication	(ASYNCHRONOUS lecture/reading) + **SYNCHRONOUS** role play/simulation with SP
3. Apply knowledge to the diagnosis and management of patient problems	Analyse and evaluate	Direct purposeful experience	Interpersonal communication	**SYNCHRONOUS** PBL/simulation with SP/ One-on-one clinical supervision + (ASYNCHRONOUS debriefing lecture)
4. Perform procedural and hands-on skills	Apply	Iconic experience	Intrapersonal communication	**ASYNCHRONOUS** demonstration video/ task training simulation/
		Direct purposeful experience	Interpersonal communication	**SYNCHRONOUS** coaching/one-on-one clinical supervision
5. Develop professional behaviours and identity	Evaluate	Iconic experience	Interpersonal communication	(ASYNCHRONOUS lecture/reading/ reflective exercises) + **SYNCHRONOUS** mentoring/ role modelling
6. Develop clinical reasoning skills	Analyse and evaluate	Symbolic experience Direct purposeful experience	Interpersonal communication	(ASYNCHRONOUS lecture/reading/ reflective exercises) + **SYNCHRONOUS** case presentation /discussion/Q & A
7. Communicate with patients and colleagues	Apply	Direct, purposeful experience	Interpersonal communication	(ASYNCHRONOUS lecture/reading/ reflective exercises) + **SYNCHRONOUS** simulation with SP/ small group discussion/ clinical supervision with feedback
8. Develop ethical reasoning	Analyse	Symbolic experience Iconic experience	Interpersonal communication	(ASYNCHRONOUS lecture/reading/ reflective exercises) + **SYNCHRONOUS** ethics case discussions/debates/ group reflective exercises
9. Develop critical thinking skills	Analyse and evaluate	Symbolic experience Direct purposeful experience	Interpersonal communication	(ASYNCHRONOUS lecture/reading/ reflective exercises) + **SYNCHRONOUS** small group discussions/ clinical supervision with feedback
10. Work within a system	Analyse and evaluate	Direct purposeful experience	Interpersonal communication	(ASYNCHRONOUS lecture/reading/ reflective exercises) + **SYNCHRONOUS** role play/ simulation/coaching
11. Participate in developing and transmitting new knowledge	Create	Symbolic experience	Interpersonal communication	(ASYNCHRONOUS lecture/reading) + **SYNCHRONOUS** discussions for research activities/mentoring/Q & A
12. Develop collaborative and leadership skills	Analyse	Symbolic experience Direct purposeful experience	Interpersonal communication	(ASYNCHRONOUS lecture/reading/ reflective exercises) + **SYNCHRONOUS** teamwork leadership workshop/ role play/ simulation/coaching

Suggested media indicated in bold is recommended for primary use, while media indicated in non-bold text is media recommended for additional use.
PBL: problem-based learning; SP: standardised patient.

convergence may delay rapid development of shared understanding.

The study may prompt revisiting the classic media debates between Richard Clark and Robert Kozma in the early 1990s. Clark argued that instructional media serves merely as a vehicle without influencing the learning process, much like a grocery delivery truck does not directly influence one's nutrition (Clark 1994). Kozma held a different position, that the features of a particular type of instructional media can crucially affect learners' cognitive processing (Kozma 1994). Although our position appears closer to Kozma's position, i.e. we propose that proper selection of synchronous or asynchronous media elicits more success in learning.

Nonetheless, we eventually reached a conclusion that incorporates and resonates with the ideas proposed by both Kozma and Clark. We propose that educators must engage in careful consideration of the order of cognitive

objectives, the concreteness of learning experiences, and the social and collaborative features of learning activities as they decide on the balance of conveyance and convergence in their instructional media. In other words, as media and technology continue to rapidly advance and provide varying features and affordances in a changing educational landscape, educators should be aware that sound pedagogical foundations should guide their use of instructional media. For example, a systematic review of virtual patient (VP) systems in medical communication training showed that the effectiveness of the VP system was determined by the quality of the design of the instructional intervention, not the level of the technology embedded in the system (Lee et al. 2020).

6.2. The characteristics of medical education from a media perspective

Our criteria for media selection corresponds to the 12 goals of medical education, which appear to be primarily served by synchronous media, with asynchronous media as a more supplemental role. Table 2 shows that convergence for shared understanding is a more dominant cognitive process than conveyance for individual mental model building in medical education. The media selection criteria we suggested are guided by the notion that medical professionals must be able to first communicate and collaborate with other physicians and teams of professionals, as opposed to the idea in traditional medical education that the acquisition of a large amount of scientific and clinical knowledge is primary and even sufficient. Our suggestions and principles reflect that medical knowledge should be shared and concretised into competency *via* the convergence processes of verifying, adjusting, and negotiating mental models for shared understanding – after learners have understood the conveyed knowledge and built their mental models on this knowledge.

Marshall McLuhan's approach to media helped to expand this idea. McLuhan's well-known aphorism 'the medium is the message,' from his influential book *Understanding Media: The Extensions of Man* (McLuhan 1964), refers to the human experience of media. McLuhan postulated that how one receives a message is just as crucial as the message itself, and that the medium, not the content it conveys, exerts individual and social impacts. In the same way that the medium of television, for example, engages viewers in a unique way and influences society no matter whether the content is a family or violent show, or something else, synchronous and asynchronous media each have their own characteristics that engage learners in a unique way whether the content, is biomedical knowledge, clinical skills or professionalism, or something else. Following McLuhan's proposition, media with synchronous affordances has the power to extend the existence of learners and to change the way they interact with others, ultimately transforming the scale, speed, and pattern of their learning environment. McLuhan's grand theory on media corroborates with our ideas about the powerful impact of media selection on leaners' cognitive process, social interaction, and overall learning ecology.

6.3. Emerging models of media selection for the new normal era

The units of a medical education course can vary in terms of the balance of conveyance and convergence processes, that is, in the balance of asynchronous and synchronous media. If we replace face-to-face, in-class learning with an online synchronous session, a class based on fully online flipped learning can emerge, i.e. flipped learning using only online platforms, which combines asynchronous online lectures that individual students learn by themselves and synchronous online learning activities in which students interact with peers and instructors (Lee 2022; Petichakis, 2022). The merits of face-to-face interaction can be achieved through synchronous media. Such a *fully online flipped learning* class would blend pre-class media for conveyance with in-class online asynchronous media for convergence. Some researchers have compared the effectiveness of fully online flipped learning with the original in-person model, and found no statistically significant difference in learners' academic performance (Jia et al. 2022; Stöhr et al. 2020).

A broader approach than the fully online flipped learning model might be *bichronous online learning* (Martin et al. 2020). In the bichronous online learning model, the blending of asynchronous and synchronous online learning is the same as in the flipped learning model, but with more flexibility in terms of sequence and specifications. Thus, knowledge delivery may be done during the online asynchronous portion, and collaborative constructive learning activities may be conducted during the online synchronous portion. A further variation is *the hybrid flexibility (HyFlex) learning model* proposed by Abdelmalak and Parra (2016). Learners can choose the way they attend a course or session – online or face-to-face in the physical classroom, synchronously or asynchronously – depending on which best facilitates their learning according to the affordances and constraints of the learning context. As the new normal in medical education emerges, these three models will naturally become implemented and will evolve for higher quality learning.

This study may be limited by its extensive integration of theories and practices. Thus, the proposed media selection criteria, design principles, and practical guides for medical education will need empirical validation for diverse educational practices. Therefore, more comprehensive research is needed on instructional media in medical education adopting related fields that are the source of knowledge, such as brain science, neuroscience, and biotechnology in order to provide a scholarly basis for new media being introduced and advanced. It is hoped that the ideas in this paper can provoke such scholarly endeavours.

In conclusion, we aimed to consider the changes that occurred during COVID-19 with respect to the impact on medical learning and the requirement to change to a predominantly online learning environment. We noted that educators were often implementing ad hoc education change elements rather than developing sound pedagogical arguments for selecting judicious methods of transmitting and communicating information. We emphasise that careful selection of online learning methods will optimise the goal of promoting deep learning. We propose that selection of online material and methods needs to be

guided by sound pedagogical arguments. We have outlined several ways in which synchronous and asynchronous approaches to communicating ideas can be optimised. We affirm that prudent selection of media synchronicity methods will determine the greatest learning affordance.

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