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Perspective

Good practices of delivery and teaching leadership for online educators in technical disciplines: A perspective

Tasadduq Imam[1,*]

[1] School of Business & Law, CQUniversity (Melbourne Campus), 120 Spencer Street, Melbourne, VIC 3000, Australia

* **Correspondence:** t.imam@cqu.edu.au; Tel: +61-3-9616 0645

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Abstract: While there are works on best practices in teaching, there is a lack of literature that concerns the associated leadership aspect. However, contemporary online educators largely play the role of leaders consciously or unconsciously. Further, STEM and technical social science subjects like finance can be related to a substantial cognitive load if instructions are poorly designed, and more so in an online context where students and educators may not have a close connection. This perspective article, drawing on the author's own experience as a successful online educator with consistently high student satisfaction scores and multiple teaching awards and referring to literature, conceptualizes good online teaching practices in technical disciplines across two dimensions – virtual leadership and cognitive load management. The perspective then suggests strategies particularly applicable in technical disciplines to achieve satisfactory learning outcomes. It is acknowledged that online delivery and style of teaching adopted by educators can be subjective and dependent on context. However, the practices suggested, including communicating expectations, developing trust-relationship with students, adaptations beyond conventional teaching and textbook, and designing and sequencing resources while considering cognitive load management, may positively impact online students' learning experience in STEM and technical social science disciplines.

Keywords: cognitive load, online teaching, STEM, finance, virtual leadership

1. Introduction

During the COVID-19 pandemic crisis, universities and higher education institutions worldwide shifted to online teaching with varying degrees of experience. Some of these institutions have historically been brick-and-mortar institutions, with online teaching being a completely new model to

them. For others, who have historically been online education providers solely or through a blend of both face-to-face and distance delivery, the shift has just been a business as usual with possibly some extension. Irrespective of such history, educators across these institutions have faced various challenges under the unprecedented circumstances brought in by the COVID-19 pandemic and the consequent public health measures and restrictions that ensued. Further, with second and more waves of the pandemic emerging across countries and in an era when individuals are increasingly getting used to video streaming and other online platforms, higher education institutions' shift to online teaching is likely to continue to some extent. It has become more critical than ever to adopt good teaching practices for effective online delivery in such a context. However, what constitutes good teaching within an online context? Further, STEM disciplines and disciplines that fall within social science but are highly technical and mathematical, like finance and economics, have certain challenges that may not be present in other disciplines. With that in consideration, what steps can educators take to cope with the challenges when delivering these subjects online?

These are the questions that this perspective article aims to answer, drawing on the author's long acknowledgement as a successful online educator further to relevant literature. Notably, suggesting some perspectives on what constitutes good online teaching is not new, and the respective literature includes different research undertakings. For instance, Edwards et al. [1] conduct a narrative inquiry on health program graduates in a Canadian university's context and identify the best online facilitators as those who demand high standards from students, provide them regular encouragement, and influence them. Research also notes that contemporary students often engage via social media and suggest tips for educators inclusive of having a clear identity, careful selection of tools, making gradual connections, and developing customized practices for educating medical concepts [2]. Another research explores how social media can be used effectively for communication training programs and recommends regularity, commitment and adaptation from educators [3]. There are also views that seasoned online teachers provide frequent and timely feedback, plan and segment course delivery with a clear structure, institute close connection and presence with students, and show agility and flexibility to adapt [4]. Price et al. [5] investigate a best practices framework [6] for online nursing education. The study recommends that online educators establish an environment supporting critical reflection, keep students focused via regular communications, value students' commitments, encourage outside class discussions, and institute diversities in learning styles [5]. Literature has further explored the determinants that influence the use of social media by online health educators [7], the need for professional development for new online learning designers [8], and providing effective feedback in online education [9].

Literature also well acknowledges the seven good practices prescribed for effective teaching in higher education [10]. A similar reflection explicitly focused on online teaching, especially for STEM and technical social science disciplines, appears missing. Indeed, as reflected by the author earlier in a media piece, online teaching can be perceived as a form of leadership [11]. There is, however, a lack of literature that has concerned the leadership aspect of online teaching. This is the novelty that this perspective on online teaching brings to the body of knowledge.

2. What is different in online teaching of technical disciplines?

There can be a question as to why we need a perspective focused on technical disciplines and what is different about them? To understand this, we can draw upon relevant literature. Firstly, STEM

disciplines and social science technical disciplines like finance and economics involve a high level of mathematical knowledge further to respective theoretical understanding, and the cognitive load experienced by students can be substantial. There is a limit of the information volume and type the human brain can process at a time, and poorly designed instruction materials can overload the working memory – the situation outlined as cognitive load in the literature [12–14]. Arguably, depending on the discipline and student diversities, the situation compounds for technical disciplines.

To put things into perspective, the author, for instance, leads the delivery of a finance subject at an Australian university. Since the finance subject is not part of a specific major but core to other programs, the students enrolled come from various disciplines, including non-business disciplines. Finance, however, is an interesting business discipline. On the one hand, finance subjects target business skill development and thereby consider soft skills, including leadership, critical reflection, and organizational management. On the other hand, contrary to many other business disciplines, finance contents are highly mathematical and share similarities with traditional STEM disciplines. Literature reflects that finance students often struggle with textbooks due to a large number of equations and mathematical knowledge requirements [15]. There is further evidence just choosing a finance textbook over others because of readability does not positively influence students' learning experience [15] – so integrated is the cognitive load in the discipline. Thus, in a context where students come from different programs and thus have different academic skills, the challenge for an educator, especially if most of these students are online students, compounds. Not only he/she needs to adopt some good practices in teaching, as recommended in the literature, there is also the need to make conscious efforts towards reducing cognitive load effectively. This calls for effective leadership on part of the educator to overcome the challenges.

This issue of cognitive load in STEM disciplines has also drawn attention. Hu et al. [16], for example, highlight that the typical problem-solving-based teaching approach in engineering and mathematics enhances cognitive load for learners and recommend the incorporation of humor to reduce this. Rhodes et al. [17] investigate if the case study-based learning approach benefits the traditional teaching approach for STEM students and note mixed results concerning the impact on cognitive load. Research also prescribes optimization of cognitive load for teaching STEM subjects to business students [18]. What is not clear, however, how many of these recommendations can be integrated in online teaching of the STEM subjects. Literature on good practices in online teaching, on the other hand, have often overlooked the aspect of cognitive load present in technical courses. This calls for an integrated reflection – a viewpoint that motivates this perspective.

Online teaching of STEM courses have an additional challenge that may not be present in some disciplines – the need for practical experimentation to further developing knowledge in the respective theories. Engineering students, for example, regularly need to conduct lab experiments and gain skills in similar undertaking needed in the professional context. Information Technology (IT) students need to develop hands-on experience with programming and coding to work as part of a project team, which entails skill development during lab works. However, how can such skills be acquired when instructions are conducted online, or in some cases through blended face-to-face and online teaching? Good practices in online teaching specific to STEM and technical disciplines need this consideration. Also, although the author, in this perspective, draws mainly on the experience of leading and conducting finance courses and some technical disciplines like finance may not need extensive lab work as needed in some core STEM courses, the challenge of managing blended learning is still present.

That is since some contemporary universities currently offer both online and face-to-face courses across disciplines simultaneously, and the educator's challenge is to adopt teaching practices that offer a nearly equal authentic learning experience for both cohorts of students. Again, acknowledging the complexities involved with teaching technical disciplines via online platforms, the need for careful consideration of blended learning remains. Thus, the recommendations offered in this article can be of value to a wide range of technical disciplines and context and, in the lack of a similar reflection, justifies this perspective.

3. Virtual leadership perspective of online teaching

An issue largely overlooked in the literature yet which can apply well within an online teaching context is the inherent virtual leadership role required of the educator. Virtual leadership is a leadership context where team members are geographically scattered, and consequently, there is minimal face-to-face contacts and the need to collaborate via electronic means to achieve the team's goal [19]. An online teaching context shares similar attributes. In this context, the educator acts as a leader responsible for ensuring students achieve the learning goals following his/her guidance and are offered support concerning personal development relevant to the taught subject. Just like a virtual leadership context, the students, who play the role of followers, can be located across places with opportunities for face-to-face interaction with the educator, i.e. the leader, being minimal. Additionally, for some universities, students are located across different campuses of the institution, and a teaching team under the guidance of a central educator conducts the delivery. Here, again, the teaching team members can be geographically dispersed, and the central educator acts as a leader not only for his/her students but also for colleagues in the teaching team. In such a scenario also the virtual leadership context appears. Indeed, having a central educator guiding a teaching team is present across higher education institutions, irrespective of organizational structure, especially when the responsibility of teaching students is shared among a group of educators. If such is the case, in outlining the best practices for online teaching, there is a need also to consider the best practices for virtual leadership.

Research on virtual leadership offers suggestions concerning effective outcomes and the various dimensions that impact leadership in a virtual setting. Malhotra et al. [19], for example, suggest multiple practices for effective leadership within a virtual context. These include creating an environment of trust and inclusiveness while acknowledging diversity, leveraging online communication tools, regular monitoring of the team's progress, and recognizing individuals for the contribution [19]. Research further notes frequency and medium of communication as factors that can largely influence activities of virtual teams [20]. Liao [21] presents a multidimensional perspective for the effective leading of virtual teams and reflects the impact of a virtual leader's behaviors at both the team and individual levels. There are also views that a virtual leadership context involves paradoxes at different levels, and depending on how a virtual leader manages these paradoxes, different styles of virtual leadership emerges [22]. The influence of different leadership styles on a virtual team has also been explored in other research [23].

The question remains that if a distance teaching context can be viewed as a virtual leadership context and there are views in the literature about what constitutes effective virtual leadership, how can the knowledge from literature be adopted to develop best practices for online teaching? - an aspect this perspective article considers.

4. Recommendations for best practices

This section provides some recommendations for online educators of technical disciplines. While there can be further research on these recommendations, arguably, these provide some practical and implementable guidance for effective teaching leadership of technical subjects within an online context. While some preliminary reflections on these recommendations appear as a media piece [11], this perspective goes beyond the preliminary reflections and draws on relevant research to justify the recommendations.

4.1. Adoption of best practices of a virtual leader

As already outlined in the last section, distance delivery can be deemed as a virtual leadership context with an educator as a leader and students as the followers. Consequently, it is essential to adopt best practices for effective virtual leadership. This adoption, however, does not occur automatically, and there is a need for conscious efforts. Virtual leadership literature regularly refers to the need of instituting a trust relationship between the leader and followers [19, 21]. Similarly, a distance educator needs to build a trust-based close relationship with his/her students irrespective of discipline. Relevant research emphasizes transparent and regular communication to develop trust in a virtual leadership context [19]. There are also views that hosting face-to-face meetings and rich use of media can bolster such trust [21]. Additionally, virtual leadership is effective when leaders and followers share similar perceptions concerning task and inter-team relationship [21].

Adapting from these views, a distance educator needs to communicate his/her expectations and overall goals of the learning activity to the students quite early in the teaching task. This is particularly important for cognitively challenging technical disciplines. Students enrolled in these subjects often possess largely different technical skills and levels of background knowledge. Thus, just providing some online learning materials like textual resources, videos, presentations, and solutions may not lead to effective learning. If students are unclear about the educator's expectations, they will form their own perception as to the learning goals and which can be quite different from what the educator expects.

Some students, for example, may focus on learning resources just as a mean of solving assignments and thereby achieve learning that is minimal or incomplete. Some others may hesitate to ask the educator for help even when they have confusions and consequently struggle with the respective topics. Some may even view the educator as an opponent who will deduct grades for each mistake they have made and, instead of clarifying with the educator, may violate academic integrity. Indeed, recent research notes that contract cheating in higher education may occur if students deem assignments as difficult or exhausting, are not prepared for the subjects, and lack guidance, especially at the start of completing assignments [24]. These can potentially occur in cognitively challenging STEM and technical social science subjects, especially if the educator is not conscious of these issues when delivering online. Research also emphasizes strengthening teacher-student interaction to reduce the incidences of contract cheating [25]. This, in turn, reflects the importance of developing a trust-based close relationship.

As Bligh [26] notes, trust implies the reliance one individual places on another individual's words or activities and affects leadership. Research further finds that followers' perception of a virtual leader's trustworthiness can be well influenced by the leader's technological savviness [27]. Adapting these, a distance educator needs to institute clear communication concerning expectations and show

some authority in using technologies further to discipline knowledge to gain credibility from students in an online learning space.

From the experience of this perspective's author, trust-building can go further. Contents in STEM and technical disciplines are not as abstract as some soft skill development focused disciplines. Consequently, it is not uncommon that students, initially, are likely to make mistakes in their assessments and experiments. However, how the educator views these mistakes and provides feedback can impact their learning experience and, arguably, trust. Recent research identifies that distance students can feel disheartened if they achieve grades well below their expectations, and the negative emotions can compound if the feedback received is perceived as insufficient or mechanical [28]. There is also evidence that the way students accept feedback from their educator depends on their belief about the educator's expertise [28]. Thus, for STEM and technical social science disciplines, it is critical not to just focus on identifying what is right or wrong or providing feedback that highly criticizes mistakes. Rather, there can be a conscious consideration of the efforts made by students in trying to solve the respective discipline problems, and the tone of feedback can be positive and constructive. Research further notes that students often seek "model answers" during feedback [29]. Thus, online educators in these disciplines can consider this and provide sample answers for both calculation and textual questions – not only this may clarify to students how well they could have answered but also convey the educator's expertise and thereby enhance trust between educators and students and in turn the learning experience of students in the respective context.

Virtual leadership literature also emphasizes forming an environment of inclusiveness [19]. This is particularly needed in an online teaching context. With students likely to emerge from various geographic locations, backgrounds, and cultures, and thereby having different learning aptitude and skills, a distance educator needs to adapt teaching style and resources to accommodate such diversity and encourage an environment of two-way communications and feedback for effective outcomes. Indeed, literature reflects the importance of cultural awareness and skills when leading in a global environment [30]. Although not generally emphasized in the pedagogical literature, distance educators, especially those from higher education institutions reaching out to students from various backgrounds, need to show a similar inclusive leadership mindset. Students in STEM and technical social science subjects may largely differ on their academic skill levels congruent to backgrounds. Further, individuals have differences in how they learn, emphasizing abstraction and some on gaining experience from practical usage [31].

For STEM and technical social science subjects, this implies textbooks, and traditional learning resources, which often assume some pre-existing knowledge and focus on formulas, models, and technical details, may not be effective uniformly for all students. Therefore, distance educators in those disciplines need to go beyond the traditional teaching approach and design resources that reflect adaptation to such diversities. In the finance discipline, for example, with textbooks largely mathematical, there is a need for designing resources that provide or refresh the background mathematics knowledge further to those covering disciple specific topics when teaching online. Explaining complex topics in layman style can also be necessary for the discipline, further to the traditional approach of instructing the technical details.

Literature highlights that an effective virtual leader manages paradoxes within the leadership context by synergizing solutions and confronting the associated challenges [22]. There is also a call for a critical reflection on professional practices as a form of personal development [32]. Arguably,

this corresponds to virtual leaders adjusting and adapting to complexities in their contexts. A distance educator, as a virtual leader, hence, needs to show the flexibility to adapt. Such adaptation can come in different forms depending on the teaching context. Further, this can vary with time. There is an impact of generation of students on their learning styles as well as their attitude towards learning [33, 34]. Consequently, a distance educator needs to demonstrate an open mindset to accommodate different learning preferences and design instruction materials accordingly.

Overall, an effective distance educator has to move away from a traditional or a legacy educator role. Rather, a distance educator, especially in technical disciplines, can embrace the best practices in virtual leadership and be an active virtual leader, rather than a passive knowledge distributor, influencing students' learning.

4.2. Conscious management of cognitive load

A second aspect needed for success in the online teaching of technical disciplines is managing the respective cognitive load. While this step partially overlaps with that undertaken in the role of a virtual leader, the management of cognitive load requires a conscious attention.

Cognitive load can be of three types – intrinsic cognitive load, which relates to the load on working memory arising from the complexity of learning resources and interconnectivity of information needed for problem solving; extraneous cognitive load, which corresponds to the load arising due to the way the instruction is planned; and germane cognitive load, which relates to the load needed for meaningful learning and is to be increased rather than decreased for effective learning outcome [13, 35, 36]. A research, further, argues that the germane cognitive load can be reasoned as a form of intrinsic cognitive load [36]. Literature also highlights that extraneous cognitive load should be decreased or removed while the intrinsic cognitive load can only be managed [36].

There are differing views as to how cognitive load can be reduced. Mayer and Moreno [33], for example, focus on multimedia-based learning and the consequent load on working memory in processing “verbal” and “visual” information. The work subsequently proposes ways to reduce cognitive load, including a balanced distribution of essential knowledge across both forms of information, careful planning of sequence of instructions, removal of unneeded information, avoidance of redundancies, and synchronizing presentation of both forms of information [37].

These recommendations well apply in technical disciplines. STEM and social science technical subjects like finance involve a substantial level of equations and math, further to theories and, in some disciplines, there are also various models and visualizations. Hence, a distance educator needs to plan carefully the presentations of these different types of visual information combined with verbal narration during a video or a live presentation. Just having an emphasis on equations in finance discipline, for example, can provide students the wrong impression that finance is not just math and there are solid and practical theories behind the concepts, with equations just a representation of those concepts. Similarly, just highlighting theories in engineering subjects is not likely to provide effective learning, and students may often memorize rather than critically think on the practicability of the theories if the information is not presented with careful planning and sequencing.

Recent research further reflects on various strategies to manage cognitive load in instructions [38]. One strategy which has achieved emphasis is a focus on interactions between learning elements [38], where such interactions correspond to whether a piece of information can be grasped on its own or is dependent on understanding other information [39]. There is further evidence that a learner’s level

can influence how they can grasp information with novice learners more comfortable with isolated elements and advanced learners deeming interlinked elements as more suitable [39].

Arguably, this conscious consideration of learners' preference and consequent management of cognitive load is well appropriate in STEM and technical social science disciplines. Educators in these disciplines often just follow the exact chapter sequence of corresponding textbooks. These textbooks, however, may not present interacting elements closely and sometimes repeat the same information in various forms. For instance, in finance, textbooks often present the same concepts and associated formula in different forms across the book, even when these different forms are just specializations of a general formula. In software engineering, students are often taught programming concepts like variables, data structures, algorithms in a programming language-specific way and are not often clarified that, irrespective of programming language and platform, some basics in programming remain the same. Thus, when the students are exposed to another programming language and platform as part of their engineering curriculum, they treat the new information in isolation even when several elements can be treated as a follow up of what they already know. Such situations can confuse students and increase their cognitive load. Arguably, within a distance learning context, the isolation between the educator and students compounds this detrimental effect. Thus, in planning an online curriculum within a distance learning scenario, it can be essential to go beyond textbooks concerning contents and consider carefully how the knowledge is presented.

Lastly, another dimension of online learning and its link to cognitive load begs attention. The dimension is "transactional presence" – the level of intimacy students perceive with their educator, peers, and institution, and which impacts their learning [40]. Such is also the experience of the author of this perspective. Thus, following Shin [40], a conscious effort in managing transactional presence is needed, especially for STEM and technical social science disciplines where the intrinsic cognitive load can be high and a feeling of isolation, arguably, can compound the effect of cognitive load.

Research identifies that the way video lectures are designed in higher education can influence students' learning, and those having instructors' "talking head" are more effective than those just narrating slides [41, 42]. Further recommendations include shortening the length of video lectures and posing enthusiasm, and incorporating some personal touch in video lectures [41, 42]. From the experience of this perspective's author, adoptions of these recommendations can increase transactional presence between distance students and educators. Students, potentially, are more likely to communicate, interact, and relate with a real person than an invisible identity lying behind narrated lectures and textual resources. Simultaneously, this increasing of transactional presence, despite not well explored literature, can enhance clarity of educators' instructions, and subsequently reduce extraneous cognitive load [43]. Thus, distance educators can combine effective video lecture and resources development strategies with a planned consideration of cognitive load management strategies to institute satisfactory learning experience in technical subjects.

4.3. Overall recommendations

Figure 1 summarizes the recommendations in the form of a two-dimensional framework. It is hypothesized that having a conscious consideration of these practices across the dimensions of virtual leadership and cognitive load management can arguably play a positive role in students learning experience, especially in technical disciplines, with their unique challenge of a substantial cognitive load.

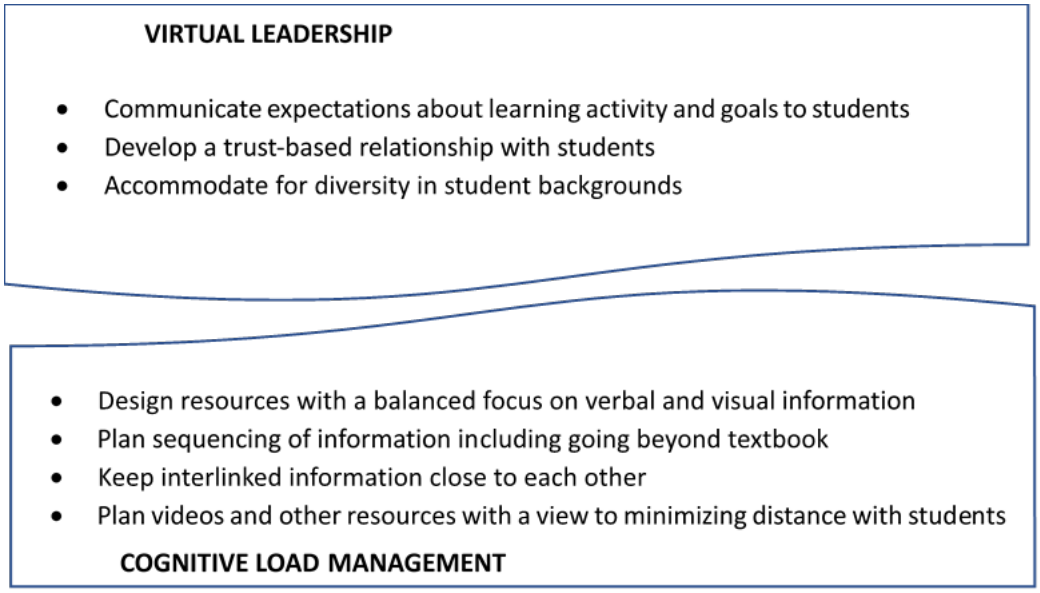

Figure 1. Good practices for online educators in technical disciplines

5. Conclusion

Overall, teaching in and leading delivery in a distance education context comes with various challenges, especially for technical disciplines. Even so, as outlined in this perspective, a reflective educator can adopt different strategies backed by literature for achieving positive learning outcomes. As indicated in a media piece by the author, teaching in the online space is not just a mechanical process, and there is a leadership component associated with it [11]. As reflected in this perspective, such leadership orientation can particularly relate to best practices of virtual leadership adapted for the educator's context. Simultaneously, a cognitive load management dimension becomes especially important in STEM and technical social science disciplines. In an online context where face-to-face interaction is minimal, ill-planned instruction in these disciplines can cause substantial cognitive load and learning dissatisfaction. In presenting the recommended practices, the author acknowledges that leadership is subjective and dependent on context and the style of different distance educators who function in their respective contexts. However, over the years, the author has adopted the suggested strategies with notable success in terms of student satisfaction, and potentially the strategies can be replicated in other contexts. Future empirical research can further assess the recommendations, especially since a conscious consideration of the leadership aspect of online delivery largely been missing in most existing works.

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