ONLINE INSTRUCTIONAL STRATEGIES

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ABSTRACT

Online instructional strategies refer to the methods and approaches that guide the organization of learning activities, course content, and student engagement in online courses.

Strategies frequently adopted in online courses include (1) promoting interactivity through asynchronous and synchronous communication or delivery (2) facilitating the application of concepts; (3) using video demonstrations, such as screencasts for demonstrating tools and programs; and (4) conveying a strong social presence or a sense of belonging to a learning community.

Online course design refers to the features that shape the overall structure of the course, including learning activities, sequence of content and communication, and structure of assignments. Research showed that students' perceptions of their overall learning experience with instructional strategies and online course design not only affected their perceived learning but also their overall satisfaction with an online course.

Online education, including innovative and responsive online course designs, as well as research on student opportunities to interact with online course content, continues to grow in education. Although the demand for online (Science and Technology, Engineering and Mathematics (STEM) courses have never been higher, little has been done to develop effective instructional and online course design strategies for teaching STEM courses online.

However, considering the reality that many online students seek online courses to avoid fixed meeting times and traveling to campus, it is practical to adopt asynchronous communication for online courses. The study results can be used to guide online teaching and learning as well as online course design for instructors, course designers, and students in STEM fields.

This paper reports the effectiveness of the instructional strategies adopted and the online course design features in a fully online course from the students' perspectives. Instructional strategies and course design for teaching online as explained and discussed in this paper.
KEYWORDS: teaching, strategies, instruction, online teaching strategies and learning.

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Despite the lack of available research on effective instructional strategies for teaching STEM courses online, more and more STEM instructors agree that STEM courses can be taught online despite their application-based nature (Akdemir 2020; Summers et al. 2020).
Data collected from participants' reflections and course evaluations revealed that a range of instructional strategies and course design features were effective and helped students learn in an online environment. If students and instructors can acknowledge their shared role as educators and learners in an online course, there are opportunities to not only overcome technical difficulties but also create an effective online learning community (Tisdell et al.,2021). As such, this study focused on examining student feedback and perspectives on the effectiveness of the instructional strategies and online course design features adopted in a completely online course.

- **Facilitating the application of course concepts**

Instructional strategies, such as problem-based learning and case studies, can provide students an opportunity to experiment and share knowledge with their peers online while exploring complex topics and concepts (Steinberg 2021; Strang 2021). Online instructors should communicate through course design features that facilitate student access and mobility in an online course, which includes easy navigation, legible, user-friendly screen design, and informative multimedia (MacGregor and Lou 2004).

Even if there was no significant difference between online and face-to-face courses in terms of learning gains, there was a difference between students' perceived learning and learning experience (Summers et al. 2021). To design an effective online course, instructors should begin with an organized course orientation including explicit directions including due dates, communication of institutional policies and ethics, and examples of assessments and projects (Robles and Braathen 2021; Song et al. 2021).

Despite these concerns, little has been done to develop effective instructional and online course design strategies for teaching STEM courses online (Akdemir 2021). As universities, schools, and organizations offer more online courses and online programs, there is an urgent need for research on online pedagogy, especially pedagogical, and discipline-based guidelines for STEM courses that are application-oriented. Student perceptions of the instructional strategies adopted in their online courses, including reflections of the online course design, have not been adequately examined in such contexts.

The demand for online science, technology, engineering, and math (STEM) courses has never been higher, and more STEM instructors are teaching or will be teaching such courses online.

Instructional strategies, which refer to specific methods and approaches that "provide the conditions under which learning goals will most likely be attained" (Driscoll, 2021) are critical factors impacting online learning and learning experiences (Fresen 2021; Schaller et al. 2021). For the organization of content, clear course learning objectives are critical to helping students identify their preparedness for a course, as well as to assist the instructor's facilitation of student learning (Bozarth et al., 2021).

▪ Promoting interaction
Students in online quantitative courses have limited access to face-to-face support and have a higher attrition rate than that in face-to-face courses (Ariadurai and Manohanthan 2020). Regardless of instructor competency, content, or student ability, the design of an online course is often among the most powerful factors impacting successful online learning outcomes (Baldwin 2021). The online course was an introductory, quantitative research course that covered common concepts and focused on the application of educational research concepts for graduate students in educational technology.

▪ Assessments and engagement
Gaytan and McEwen (2021) suggest that while effective assessments in online courses may vary, students and instructors perceive that the most effective assessments include frequent, formative assignments, as well as projects, portfolios, peer evaluations, and self-assessments.

Students may need time to explore the course components, as well as explicit directions regarding expectations of an online course, such as communication norms (netiquette) and collaborative discussions (Moallem 2021). For online course design features, consistent structure, various resources, and learning activities, and the application-focused course content were found to be effective.

▪ Instructional materials and the use of technology
Instructors can control many elements of an online course, including the presentation of materials and the communication of content. Weir (2021) suggests that instructors imagine perceiving their online course content through the eyes, ears, and touch of students who are blind, deaf, or physically impaired while developing course materials. To make necessary modifications and adjustments, online STEM instructors need to be informed of online pedagogy research as well as trained in online instruction (Huber and Lowry 2021). Many students new to the online setting may not comprehend the time commitment that is required of asynchronous courses and will need to maintain effective time management strategies to avoid falling behind (Bozarth et al. 2021). Instructors should emphasize the applications instead of abstract theory whenever possible and integrate mathematical and statistical software throughout courses to highlight the authentic application of concepts, methods, and procedures, and collaborative learning to encourage students to play a more proactive role in their learning (Juan et al. 2021). These interactions affect not only how students perceive their learning and the overall educational experience but also the perceived quality of the instruction and learning in an online course (Bonk and Cunningham 2020).

Student-to-instructor interaction refers to dialog between students and the instructor, as well as the engagement of the students and instructor in the learning and teaching process (York et al. 2021). One important component of an online course structure is the conceptual mapping of objectives to assessments, which provides the focus for students (Swan et al. 2012). Frequent communication between students and their instructors, as well as between students and their peers, promotes student engagement in online courses.

Finally, soliciting student feedback or becoming responsive to student difficulties early in the course will allow the online instructor to reconsider the presentation or implementation of course materials. Students should be expected to know the importance of time management and to make visits to the online course (website) part of a daily routine (Song et al. 2021). The purpose of this study was to identify the kinds of online instructional strategies and course designs that effectively helped the students learn statistical concepts. In addition to making use of institutional support and the available features of an online course hosting system (e.g., blackboard and Moodle), instructors should seek to add various course contents.

▪ Learner support and accessibility
Supporting the learner through environmental or content difficulties is essential for online course design. In an online course, videos demonstrations of SPSS for performing certain statistical tests and procedures can be equivalent to hands-on lab sessions where students practice statistical tests or procedures with SPSS.

▪ Creating a sense of social presence
Creating a strong sense of social presence or belonging in an online environment is also extremely beneficial for students wrestling with mathematical concepts and procedures (Zhang and Walls 2021). To date, little has been done in developing effective instructional strategies and online course design techniques for STEM instructors (Bonk 2021; Yang 2020).

As one of the primary modes of online course participation, online discussions and interactions are crucial. In

addition, students' perceptions and attitudes have not been adequately examined when investigating important indicators of successful learning in online statistics courses (Myers and Schiltz 2021). Majeski and Stover (2021) suggest online instructors provide friendly, welcoming posts to keep students up-to-date on-course activities. However, teaching online is a fundamentally different experience from that of teaching in a face-to-face setting (Davis and Snyder 2021; Juan et al. 2021). There are three types of interaction in online courses: student-to-instructor, student-to-content, and student-to-student interaction (Moore 2020).

In most cases, course design drives the instructional strategy adopted in online courses. While some elements of an online course may be predetermined by an institutional template, the presentation and communication of content, resources, and communication preferences or norms can often be structured by the instructor. Encouraging students to respond to each other and the instructor in ways that demonstrates critical thinking and application of course concepts can also promote higher-level cognitive skills (Davis and Snyder 2021).

Most previous studies examining the effectiveness of online statistics courses focused on learning gains (Myers and Schiltz 2021). In their interactions with students, instructors should consider the social learning experience of the students and seek to become familiar with student learning preferences and concerns (Diaz and Cartnal 2021). The widespread use of smartphones and mobile applications makes online courses appealing to students who conduct coursework remotely, furthering the concept of learning anywhere and any place (Smith 2021).

The design stage of an online course is also the time to prepare for the needs of learners with disabilities (Pearson and Koppi 2021). Instructor profiles posted on a course website encourage students to realize that they are connecting with real people and have the desired access to instructor support (Huan et al. 2021). The lack of appropriate and deep interaction is a common issue in online courses because students and instructors are located in different geological locations (Moore 2021).

In practice, online courses are increasingly being offered to maximize learning opportunities and reach more students. For example, teaching an online experimental science course is acknowledged to be difficult (Mosse and Wright 2021) due to the required live demonstrations, associated safety concerns, and must-have equipment (e.g., lab supplies). It is even more challenging to teach science, technology, engineering, and math (STEM) courses completely online because these courses usually require more hands-on activities and live demonstrations.

▪ Using video demonstrations

Using video demonstrations can greatly enhance online teaching. Student-to-student interaction refers to the dialog and exchanges between and/or among different participants in an online course. Instructors teaching online often find the experience more difficult and time-consuming (York et al. 2021).

CONCLUSION

There are instructional strategies for organizing learning activities, course content, and student engagement in online courses. Majeski and Stover suggest online instructors should identify students new to online learning and e-mail them individually to welcome them to class to promote a good sense of belonging. During course development, instructors should make use of different instructional strategies including live presentations, laboratory tutorials and simulations, discussions, and peer collaboration to support learning activity, exploration, and creation that may help students construct their knowledge.

The implications of this study include effective instructional strategies and online course design for application-oriented STEM courses such as physics and engineering. The following section discusses the general structure of an online course, which refer to online course design features. Although educators agree that these courses can be taught online despite their application-based nature, little has been done in developing effective instructional strategies for teaching such courses online.

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