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Best Practices for Monitoring Students' Cognitive Load in Online Courses: A Case Study at a University in Iowa

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Abstract

This qualitative case study explored professors' perceptions of monitoring cognitive load in their online course content design and online course structure design in the Canvas learning management system (CLMS) at a university in Midwest Iowa. Through the purposeful sampling technique, five university professors, who have taught online courses in the CLMS, were selected as research participants for the research. Data from interviews, observations of online courses in the CLMS, and documents collected from online courses were gathered and triangulated through the constant comparison and open coding methods. The findings showed that six best practices: utilizing the Bloom's Taxonomy, aligning instructional elements, utilizing the built-in features in the CLMS, creating more autonomous and collaborative activities, effectively combining various multimedia, and implementing consistency) helped monitor cognitive load in online courses for students. Ultimately, the research findings could be transferred to the similar online teaching contexts.

Key words: Cognitive Load, Online Education, Content Design, Course Design, Best Practices

Introduction

Over the recent years, online courses, which have been offered in the Canvas learning management system (CLMS) at a university in Midwest Iowa, have expanded rapidly. As the number of online courses and degree programs at the university continues to increase, more faculty are being asked to design and develop online courses. However, sometimes the online course design and development process is done in a short time period with limited planning, preparation, and dedication. Such online course design and development process not only negatively influences the quality of online offerings, but also negatively impacts students' online learning effectiveness. Online education challenges faculty to think about considerations and changes towards improving online course quality.

How does an effective online course look like? An effective online course should provide communication opportunities between learners and instructor, interaction with their peers, and interaction with content (Chickering & Ehrmann, 1996 and Moore, 1989). However, it appears that those elements are unequally developed, misaligned, or frequently missing from most of online courses (Dao & Ochola, 2019). In addition, many instructors still simply adopt the instructional strategies and course format that they are familiar with their face-to-face courses and attempt to duplicate or convert the strategies and course format in the online teaching context (Moller, Foshay, & Huett, 2008). The missing elements and wrong assumptions from many instructors in online courses significantly influence the quality of online course offerings. Morrison (2013) declares that instructional designers should be available and should be required for faculty in designing online courses.

The researcher, a lead instructional designer, in this study had opportunities to work with different instructors who taught online courses in the CLMS for different departments and colleges at the university in Iowa.

The researcher had opportunities to interview instructors, observe instructors' online courses, and collect documents from their online courses. The researcher paid much attention to best practices to monitor cognitive load from online courses to maximize student's learning performance. Specifically, the researcher focused on how online course content design and online course structure design decreased cognitive overload for learners. The two following research questions guided the study:

1. How does online course content design impact students' cognitive load?
2. How does online course structure design impact students' cognitive load?

Literature Review

Cognitive load theory is an instructional theory based on knowledge of human cognition (Sweller, Ayres & Kalyuga, 2011). The cognitive load theory highlights the role of cognitive capacity in working memory for successful learning outcomes (Sweller, 2010). The theory has used aspects of human cognitive architecture to generate experimental and instructional effects. Cognitive load theory deals with the limitations of short-term memory and its interaction with an unlimited long-term memory (Sweller, 1988). Cognitive load theory is concerned with the learning of complex cognitive tasks, in which learners may be overwhelmed by the number of interactive information elements that need to be processed simultaneously before effective and meaningful learning occurs.

In his view, Sweller (1998) discusses three types of cognitive load: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load. The three main types of cognitive load have to be considered by instructors in determining the most suitable instructional strategies for learners to maximize their learning outcomes.

1. Intrinsic Cognitive Load:
   Intrinsic cognitive load refers to the intrinsic complexity of information being learned by a learner. Intrinsic cognitive load imposes on short-term memory of a learner. The load exerted on a learner depends on the complexity of the tasks or concept being presented to a learner and a learner's ability to absorb the new information. Learners' abilities and levels greatly differ from one another, so the intrinsic cognitive load learned materials need to be varied. Specifically, the information complexity of learning materials is determined by the level of element interactivity (Sweller, 1999).
2. Extraneous Cognitive Load:
   Cognitive load theory is primarily concerned with techniques designed to reduce extraneous cognitive load. Unlike intrinsic load, extraneous cognitive load refers to how the subject material is presented rather than its inherent difficulty. The instructor can either heighten or reduce its effect. The instructional materials are imposed by the actual instructional techniques, procedures, and materials used during instruction. It is any extra and unnecessary thinking that students have to do that does not contribute to their learning. An example of the extraneous cognitive load is to introduce overly complex e-learning tools where the learner spends more mental effort understanding the tools rather than learning the concepts from the tools. Extraneous cognitive load is not good for learning because it can hinder the construction of long-term memories. Extraneous cognitive load results from poorly designed instructional materials (Sweller, van Merriënboer, & Pass, 1998).
3. Germane Cognitive Load:
   In contrast to intrinsic and extraneous cognitive loads that put heavy emphasis on characteristics of materials, germane cognitive load only deals with learner characteristics. Also, germane cognitive load refers to processes which are connected to relevant learning. Germane cognitive load is produced by the construction of schemas. It refers to the working memory resources that the learner devotes to dealing with the learning materials associated with the intrinsic and extraneous cognitive loads. Germane cognitive load is considered to be desirable because it assists in learning new skills and other information. As a result, instruction should be organized to stimulate learner's autonomous learning and collaborative learning, so learning will be maximized (Sweller, 2010).

Research Methodology

The purpose of this research was to investigate the professors at a university in Iowa regarding their perceptions of monitoring cognitive load in their online course content design and online course structure design in the CLMS.

This research was bound in the qualitative paradigm that involves collecting information about personal experiences, introspection, life stories, interviews, observations, historical stories, interactions, and visual text which are significant moments and meaningful in people's lives (Denzin & Lincoln, 1994), Lincoln & Guba (1985), Merriam (1998), and Patton (2002).

Participants:

For this research, the researcher deployed the purposeful sampling technique to select participants. The main goal of purposeful sampling was to focus on particular characteristics of a population that were of interest, which would best enable the researcher to answer the research questions (Erlandson, Harris, Skipper & Allen, 1993). The selection of the participants for this research was based on the interests of the instructors who were willing to share their best practices in monitoring cognitive load of their online course content design and course structure design in teaching online courses at a university in Iowa.

Data Sources:

Data collection is about asking, watching, and reviewing. The researcher has to select data and select the techniques of data collection (Merriam, 1998). For this qualitative research, the researcher utilized three forms of data collection: (1) Interviewing, (2) conducting online course observations, and (3) mining data from documents.

Data Collection:

Interviews:

The researcher interviewed five professors who have experienced online teaching in the Canvas learning management system at a university in Iowa and listened to their stories and experiences. Pseudonyms were used in this research. I had a face-to-face interview with professor Midobuchi in a meeting room on the university campus in the late fall 2018 semester. I had virtual interviews via ZOOM from a meeting room on the university campus with professor Cooper in the late fall 2018 semester, with professor Anderson, with professor Wilson, and with professor Burns in the early spring 2019 semester.

Observation:

The researcher asked the professors for permission to access their online spring 2019 courses in the Canvas learning management system. I recorded systematic observations of the online course content design, online course structure design, the class synchronous as well as asynchronous discussions, and the interactive behaviors between the instructors with the students and among the students themselves during the semester. These observations were used for the data analysis process.

Documents:

The researcher collected documents from professors' online syllabi, schedules, lists of assignments, discussion plans, and the students' feedback on online courses. All the documents were kept in a separate folder for each professor for the data analysis process.

Data Analysis:

The researcher first put all the data (transcripts from the interviews, observation notes, and documents) from each professor in one folder with their name on it. All of this information was well-organized in a safe and convenient way so that the data could be easily retrieved later (Rossman & Rallis, 2003). Secondly, I looked at each set of data to familiarize with it. Next, I began to code the data by the interviewees' initials, dates of each interview, the interview numbers, the interview transcript lines, the page numbers of the transcript. Coding helped me to access the data as part of the audit trail. *Figure 1* below shows an example of a coded unit.

Fig. 1. ***Sample Participant Data Card***

Ref. #	Participant	Interview/ Document	Date	Source
[1]	1.	Interview # 1	Dec. 5, 2018	111-112, p. 3

The final step in the data analysis process was to search for themes and to establish categories. In the process of analyzing the data for this research, I identified six emerged themes (for online course content design and online course structure design). The following six themes emerged and supported the research questions. *Table 1* below showed the emerged themes that the professors utilized to monitor students' cognitive load.

Table 1. ***Emerged Themes***

Emerged Themes
Utilizing the Bloom's Taxonomy
Aligning Instructional Elements
Utilizing the Built-in Features in the CLMS
Creating More Autonomous and Collaborative Activities
Effectively Combining Various Multimedia
Implementing Consistency

Research Findings

The purpose of this research was to examine perceptions of the professors who experienced in monitoring cognitive load in their online course content design and online course structure design in the CLMS at a university in Iowa. The two above-mentioned research questions guided the study. The data collected from the interviews, online course observations, and documents collected from their online courses were triangulated and analyzed. The data showed three strategies to control cognitive load to maximize student learning: (1) decreasing the intrinsic cognitive load, (2) decreasing the extraneous cognitive load, and (3) increasing the germane cognitive load for the online course content design and online course structure design areas.

Course Content Design Had Strong Impacts on Students' Cognitive Load.

1. *Utilizing the Bloom's Taxonomy in Course Content Design*

The participants in the research all acknowledged that utilizing the Bloom's taxonomy in designing the course content was useful. The professors utilized the appropriate levels in the Bloom's taxonomy to scaffold their student learning. They designed the content to help students understand concepts in the program and to help students apply the gained knowledge to real life situations through various engaging activities.

Professor Cooper indicated:

> Nowadays, students need skills that help them solve problems and help them think critically in and out of the classroom. In order to help students achieve their higher order thinking skills, I utilize the Bloom's taxonomy in designing course learning objectives, assignments, and assessments. I have been more consistent about using Bloom's taxonomy in modules (pp. 283-287).

Professor Cooper showed a specific example in the course content design to scaffold student learning. She said:

> … I create instructive lectures that show here's how you're going to do this part of your assignment, you know, or here are some frequent questions about this or whatever. So I'll do those to demonstrate how to do things. And those are, those are helpful (pp. 337-341).

Additionally, professor Midobuchi shared her experience in utilizing the Bloom's taxonomy in designing the course content. She expressed:

> … I am looking at the Bloom's taxonomy. I'm looking more at the extent of difficulty, you know, going from description to understanding, to analyzing, um, a little more, um, cognitive load I think can be reduced to by reassurance - telling students no matter what the difficulty that they couldn't do it because if they can't, there's great support (pp. 780-784).

In order to help students effectively achieve learning, professor Anderson shared his experience in designing course content. He expressed:

> … Not just designing the course, using something like Bloom's taxonomy, but making clear to the students the different kinds of learning expectations that I have of them for different kinds of activities is absolutely integral to what I do and all my assignments (pp. 1219-1222).

Professor Wilson supported the ideas of utilizing the Bloom's taxonomy in designing the course content, but he also shared another way to decrease students' intrinsic cognitive load by reorganizing the course module. He said:

> … Each module has a specific objective in the sense that you know, this is what I want to accomplish. I have a theme for that week. That is what I'm going to teach from that theme (pp. 1864-1867).

The data showed that the participants designed a variety of learning activities (e.g., joining discussions, taking quizzes, or writing reflections) utilizing the appropriate levels of the Bloom's taxonomy to scaffold student learning, to reduce intrinsic cognitive load, but to increase germane cognitive load for their students.

2. Aligning Instructional Elements in Course Content Design

Aligning instructional elements means that all critical course components work together to confirm that students achieve the stated learning outcomes (Dao & Ochola, 2019). All the participants in the research addressed that instructional alignment elements not only helped students achieve the stated learning outcomes effectively, but also helped students decrease their intrinsic cognitive load.

[

Professor Cooper shared the importance of creating instructional alignment elements in her course and modules. She said:

> …. Instructional alignment elements are crucial. You know, if there's an assessment around an objective, how much earlier they need, what's the right timing for the content, and then what is a good way for them to be able to gain the content, explore the content, and then lead up to the assessment (pp. 232-236).

Sharing about the importance of aligning instructional elements in the course and the module, professor Midobuchi stated:

> ... Course objectives are important. The course objectives guide alignment for both me and the students. You have those objectives. Your readings really match those objectives and your lecture speaks somewhat to those objectives and your assessments (pp. 725-727).

Professor Anderson also agreed that instructional alignment elements in the course and in modules were necessary for students. He expressed:

> … It is important to have learning objectives. These objectives tell you how to get there. It is much easier to find relevant assessments and that kind of context and content for the course (pp. 1175-1178).

In order to support the instructional alignment elements in the course and in each module, professor Wilson said:

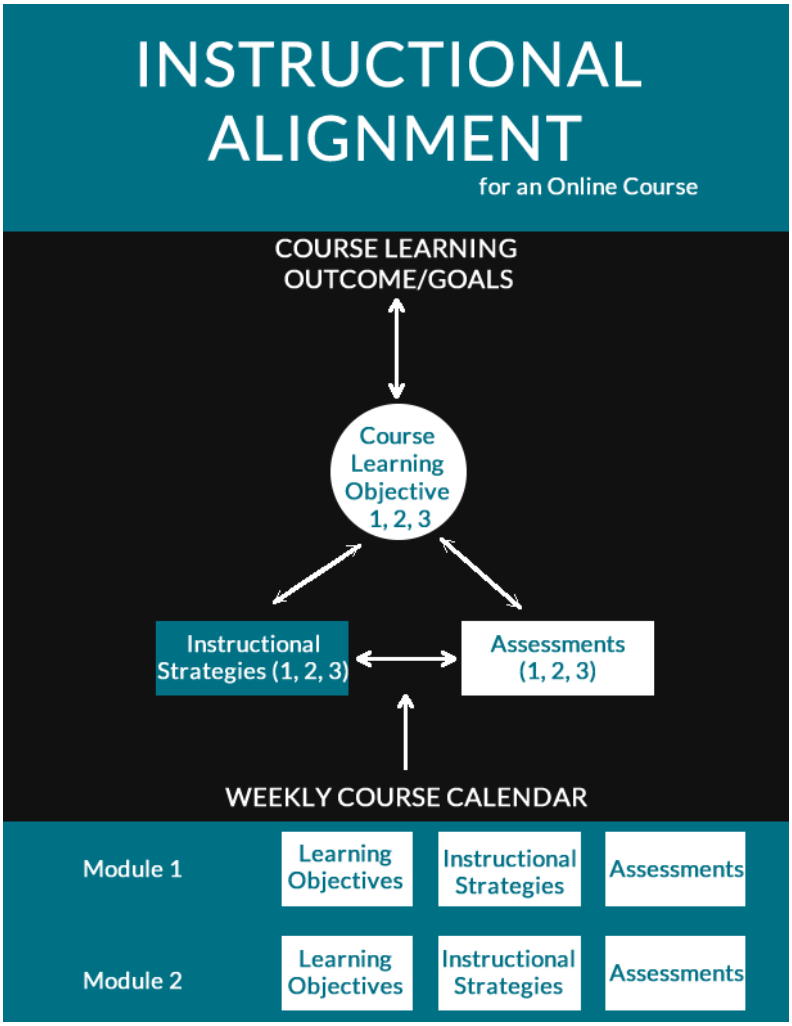
> The learning objectives for the course and for every module are necessary. It is important to come up with what is important to be taught, teach those things, and then assess from there. The instructional alignment elements effectively reduce cognitive load for students (pp. 1815-1816).

Professor Burns highly supported the instructional alignment elements for every course module. She strongly indicated:

> … My objectives that I have written out for that week are connected to the lectures, connected to readings, and connected to assignments. They are all related to one another. Students have a good flow of learning (pp. 2242-2243).

Figure 2 below shows the instructional alignment elements for an online course.

Fig. 2. *Instructional Alignment Element*



The participants implied that the instructional alignment elements not only helped the instructors effectively design the course content, but also helped students logically learn and maximize their achievement. In other words, instructional alignment elements contributed to decreasing intrinsic cognitive load for students.

3. *Utilizing the Built-in Features in the LMS*

The data showed that the participants utilized the built-in features in the CLMS to design the course content and learning activities where they could be easily accessed by the students. I did not see any complex e-learning tools in their courses where students had to spend more mental effort understanding the tools rather than learning the content. Basically, the participants chose the built-in discussion thread, assignments, and quizzes features as tools to implement online activities for their courses.

Sharing experiences about utilizing the discussion feature in the CLMS, professor Cooper said:

> Discussion feature in Canvas is wonderful. I offer students opportunities to share information. I set up a discussion board. Students are familiar with discussion in the CLMS. You know, discussion boards help students, their classmates, and others grow. So, they have an opportunity to contribute as well (pp. 196-199).

Similarly, professor Midobuchi shared one of the activities that was created in the discussion board in the CLMS. She expressed:

> I love the discussion feature in Canvas. I've just developed a new scavenger hunt. We have to introduce ourselves to the class. So we have to tell two truths and a lie in the discussion forum. The students post three things: two are truths and one lie. They have to read and guess what's not so true (pp. 542-544).

Supporting the built-in features in the CLMS, professor Anderson utilized the assignments feature in the CLMS to create learning activities for his students. He indicated:

> I use the built-in assignments feature in the CLMS for my activities. At the end of each of the short videos, I give the students something to do. Say, okay, so you, it's either a kind of a summary kind of activity, you know, write a paragraph about what we just talked about and upload their thoughts via the assignments thread. It is very convenient (pp. 1102-1107).

Similarly, professor Wilson supported the discussion feature in the CLMS, and he said:

> The discussion feature in Canvas is cool. You know the importance of the introduction at the first day. You know, um, let's everybody introduce themselves in the discussion thread. I want you to tell a little bit, I want your name, you know, what's your major? Something interesting about yourself. I use the discussion feature every week for my course (pp. 1694-1699).

Regarding the built-in features in the CLMS, professor Burns did not use the quiz feature in the CLMS, but she used the assignments feature to create learning activities for the course. She expressed:

> … I don't have quizzes for the students. You know, I'm honestly not really willing to do that. But, there are always self assessments they can do at the end of those chapters through reading. I like using the assignments function that meets my expectation (pp. 2247-2249).

As a matter of fact, the built-in features in the CLMS worked well with the participants' courses, and the instructors effectively utilized the built-in features for their online courses to meet their teaching expectations. The participants also implied that utilizing the built-in features in the CLMS was one of strategies to decrease extraneous cognitive load for the students. The students did not have extra training or spend more mental effort understanding the tools rather than their course content. From the online course observations, I did not see other external e-tools in their courses.

4. Creating More Autonomous and Collaborative Activities

Unlike traditional classrooms, online learning environments foster additional learning experiences where students can interact, collaborate, and take ownership of their own learning. Creating autonomous and collaborative learning activities helps increase the germane cognitive load for learners. The professors in the research valued the importance of autonomous and collaborative learning, so they created a variety of learning activities for their online courses. They were willing to share their experiences in creating autonomous and collaborative activities. Professor Cooper expressed:

> … I try to make the students interactive and, and shake up the, um, resources that they are utilizing. So I use a variety of readings, podcasts, videos, um, different things like that, which I think appeals to different kinds of learning. Uh, again, I try to have most of my stuff application based on that, you know, they want more practice on applying things. They don't want to just learn what something is. They want to learn how to do it (pp. 174-178).

In addition, professor Midobuchi indicated that working together on team projects was effective for students. She indicated:

> … We have lots of activities with every team activity. There's a warm activity of team building that addresses team building in different ways. So my activities, I use discussion forums, I use group work, teamwork. I use community engagement work assessments (pp. 534-537).

Similarly, professor Anderson mentioned that lecturing in the online course was not effective, but application was more important for students in the online learning environment. He said:

> … Where there's just little tiny introductions to basic concepts and then very quick applications of them returned to expanding on them rather than, you know, here's a big chunk of information and I'm going to be talking and talking. And talking and now you have to remember all of that and apply all of it and thinking that it's, it's a good system (pp. 941-943).

Professor Wilson also shared his online teaching experience to motivate students' collaboration. He really enjoyed the discuss forum in the CLMS to get students involved in active learning. He said:

> Discussion board is an excellent tool to motivate students' engagement. I have a discussion topic every week. Well, I try to engage and I try to get them involved in the discussion in an online environment (pp. 1768-1770).

Supporting the ideas of creating more autonomous and collaborative activities to increase germane cognitive load for students, professor Burns created three discussion topics for the whole class and created ten group discussion topics throughout the spring 2019 semester in the CLMS. She said:

> … I create the first three discussion threads for the class as a whole. You know these are good opportunities for them to be familiar with online content and online peers. Then I create ten group discussions throughout the semester. They have a chance to interact with one another in the groups and learn from their peers, you know. It is very effective (pp. 2246.2251).

The data showed that the instructors created a variety of engaging activities for students. Through the activities, the students had opportunities to maximize their learning with low intrinsic and extraneous cognitive loads. Their germane cognitive load increased when they had opportunities to dedicate to interactive activities.

Course Structure Design Had Strong Impacts on Students' Cognitive Load.

5. *Effectively Combining Various Multimedia*

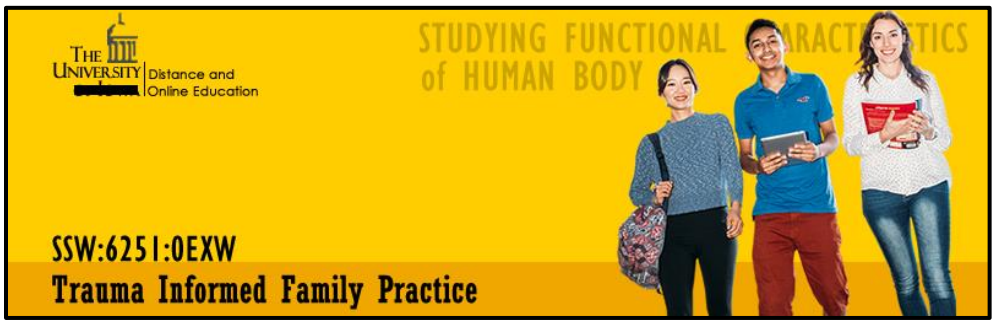
Cognitive load relates to the amount of information that working memory can hold at one time. Since working memory has a limited capacity, instructional methods should avoid overloading it with additional activities that don't directly contribute to learning. The data showed that the professors utilized different types of multimedia for their online course design to meet different types of learners and to monitor cognitive load in learning for the students.

Specifically, professor Cooper indicated:

> … I use a variety of readings, podcasts, videos, um, different things like that, which I think appeals to different kinds of learning. Especially for the course home page, I utilized effective color, text, and images to engage students (pp. 174-175).

The *Figure 3* below illustrated the homepage image of professor Cooper's online course in the CLMS.

Fig. 3. *Sample Course Homepage*



Professor Cooper also shared her experience in creating videos supporting the teaching content. She said:

> I did lectures that were about the content of the major textbook to make sure students got the main points for those chapters. What I mostly do is I'll take the topic of that module and do a lecture where I'm trying to weave in some of the reading, the big major points of the readings. I post the video at the end of that module content page in the CLMS so that students can review the content of the week (pp. 331-335).

Additionally, professor Midobuchi shared some ways to design the course to reduce intrinsic cognitive load for her students. She mentioned:

> I had a course tour, and I posted it on the course homepage. I had videos with some pop quiz items to engage students with the content. I balanced between text and images for every module. Every one of my modules for example, I created colorful module banners that show you vegetables, radishes for one module, asparagus for the next module, and carrots for the next module and so on (pp. 769-773).

The *Figure 4* below illustrated the module banner for professor Midobuchi's online course in the CLMS.

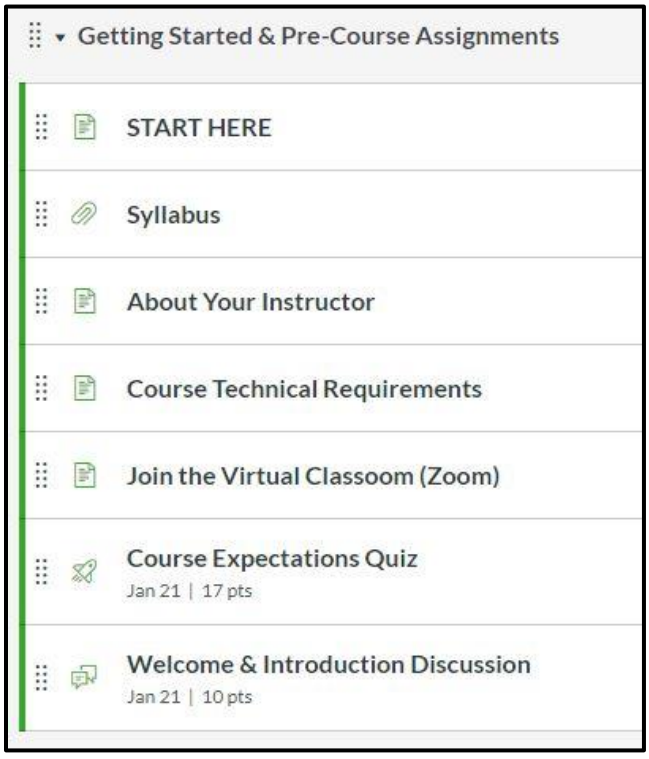
Fig. 4. *Sample Module Banner*

Similarly, professor Anderson also shared his ideas about online course design to increase germane cognitive load for students. He said:

> I created pages like the standard checklist. You know it just gets rid of all kinds of anxiety for students. Also, for the very first day of our live zoom meeting, I spend a lot of time kind of going through the pages under the Getting Started module in the CLMS and going through, um, uh, you know, my expectations for the course and all the technological stuff. I created a welcome orientation kind of video. You know that anxiety and that, that kind of, um, fear and uncertainty is removed from their thinking by the time they attend their first discussion section (pp. 1045-1051).

The *Figure 5* below illustrated the Getting Started module of professor Anderson's online course in the CLMS.

Fig. 5. *Sample Getting Started Module*



Professor Wilson shared some best practices to monitor cognitive load for his students in the online learning environment. He combined short videos, PowerPoints with good images, readings, and related short videos on YouTube for his course modules. He said:

> I really liked videos. I really do. I prefer videos to send it out. I created short and descriptive response videos to what I want from the students. The videos are usually about 2-3 minutes long. I posted the videos at the beginning of each module. You know, sometimes, I'll set up a video conference where all of us are talking at the same time (pp. 1844-1849).

Sharing about utilizing multimedia for his online course module, professor Burns said:

> I used quite a bit of visuals in PowerPoints. I mean, every slide has something kind of demonstrative of the content. I do have images. I had parallel structure from lecture to lecture. They all look very similar to one another except the images are going to be different. I posted the PowerPoints under the videos in each module to support student learning (pp. 2293-2296).

The *Figure 6* below illustrated a sample PowerPoint in one of the modules in professor Burns's online course in the CLMS.

Fig. 6. *Sample PowerPoint*

As a matter of fact, the professors utilized different types of multimedia to present their course content. The data showed that effectively combining various multimedia in course modules benefited different types of learners, decreased intrinsic cognitive, but increased germane cognitive load in learning for the students.

6. Implementing Consistency

Consistency is one of strategies to monitor the cognitive load of an online course for learners. Consistency makes it easier for learners to move ahead with the learning instead of wasting mental energy trying to figure out how to navigate pages in the course, to perform an activity, or to have access the course content. Since the professors in this research had opportunities to work with instructional designers on campus, they had somewhat consistent strategies in course structure designs, color schemes, icons, due dates, and so on when designing their online courses.

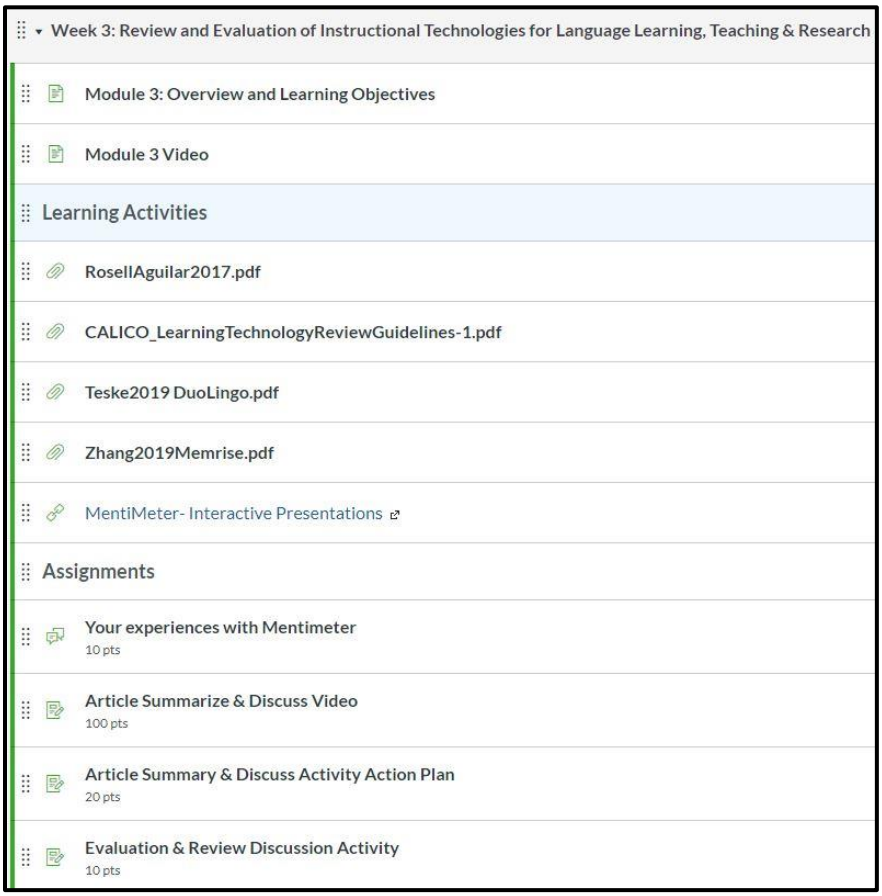
Sharing the importance of consistency, professor Cooper said:

> We really need consistent due dates. Like assignments are always due on Wednesdays, you know, that kind of thing is very valuable to students. Um, I think having consistent colors and format creates a more cohesive experience (pp. 104-106).

The data from observations and documents showed that all of the assignments for his course were due at 11:59PM on Wednesdays. The due dates created a good habit for the students. In addition, the professor utilized the university color to create module banners for the course to make them distinguished.

Supporting consistency, professor Midobuchi mentioned that the consistent course structure helped students a lot in navigating the course content. Professor Midobuchi consistently created modules by modules throughout the course. Each module consisted of a course overview and learning objectives section, learning activities section, and assignments section. These module sections aligned with those in the course syllabus. The *Figure 7* below showed the module format consistency in her course.

Fig. 7. *Sample Module Format*



Besides the consistent course structure and module structure, professor Anderson also created the consistent narrative module page in which the learning objectives, learning activities, assessments, and module summary were specifically narrated for students throughout the semester. He said:

> The students will have a sort of like this is what we're going for, here's the activities that you need to complete, here's the order that you need to complete them in. And then here's a kind of a summary for purposes of review for later on in the semester so that they have like, um, a worksheet that guides them step by step through everything that they need to do (pp. 1021-1024).

Professor Wilson supported the ideas of due dates, course structure, and module format consistency. Also, he mentioned that creating consistent content or learning activities for students was very helpful, and the consistency helped reduce students' extraneous cognitive load. He expressed:

> I am very consistent in content design. I ask myself "what is the goal I want to achieve? When am I doing that? What am I going to teach? What is the best approach?" You know, I like videos, I really do. I have a short introduction video at the beginning of each module to guide students to the module. I create one or two videos that supplement the module content. I try to keep the same format like that modules by modules (pp. 1828-1834).

Contributing to the value of consistency in online teaching, professor Burns said that providing consistent feedback on students' work was one of the best practices to show his presence and engagement in class. The data showed that he created a discussion forum where all questions were responded no later than 24 hours. He also created a communication plan that scheduled the consistent time for feedback on assignments, discussions, and projects. The course was really engaging. Professor Burns shared:

> The communication plan keeps me on the tasks. Besides, you know, I want student feedback on my course regularly. You see I often post some questions like: What would you like to know more about in this course? Or what didn't you learn that you hope to? What did you not hear about? Write me if you have comments (pp. 2379-2381).

In short, the professors supported the importance of consistency in online courses. The data showed that simple consistent implementation to course structure design made huge impacts on student learning. Consistency helped decrease extraneous cognitive load but increased germane cognitive load for students.

Discussion

The purpose of this research was to examine the professors' perceptions of monitoring cognitive load in their online course content design and online course structure design in the CLMS at a university in Iowa. The participants were selected based on the purposeful sampling technique. The findings showed that the online course content design and course structure design had strong impacts on students' cognitive load. The findings answered the research questions and supported as well as contributed the literature.

First, the professors in the research all agreed that the online course content design had strong impacts on students' cognitive load. The data showed that the participants utilized the Bloom's Taxonomy in designing various activities to scaffold their student learning to decrease intrinsic cognitive load, but increase germane cognitive load for their students. In addition, the participants aligned the instructional elements (learning objectives, learning activities, and assessments in every module throughout the course, and the instructional alignment helped students reduce intrinsic cognitive load and achieve their learning goals. The data also showed that the participants got benefits from the built-in features in the CLMS and limited to using external e-learning tools to reduce extraneous cognitive load for their students. Moreover, in order to increase germane cognitive load for students, the instructors designed different autonomous and collaborative activities. The activities helped students constitute working memory resources that they devoted to dealing with the intrinsic cognitive load associated with the information.

Additionally, the participants supported that online course structure had strong impacts on students' cognitive load. The data showed that the professors effectively combined different multimedia, such as videos, podcasts, images, and text in every module in their courses in order to meet different learning styles and reduce extraneous cognitive load for students. Besides the different modes of multimedia, the professors maximized consistency in the course. The data showed the professors consistently created the modules throughout the course. The same module content page structure was duplicated for every module throughout the course. In addition, consistent due dates were applied to assignments (e.g., discussion, project assignments, or quizzes). The consistency not only built good learning habits for students, but also reduced extraneous cognitive load but increased germane cognitive load for students.

The tables below summarized the best practices to control cognitive load for students in online courses in the CLMS.

Table 2 summarized the best practices to decrease intrinsic cognitive load.

Table 2. *Best Practices to Decrease Intrinsic Cognitive Load*

Cognitive Load	Content/Structure Design	Best Practices
Decreasing Intrinsic Cognitive Load	Course Content Design	Utilizing the Bloom's Taxonomy - Creating learning objectives, learning activities, and assignments - Creating instructive videos for assignments.
		Aligning Instructional Elements - Aligning learning objectives with learning activities, and assignments/assessments
	Course Structure Design	Effectively combining Various Multimedia - Utilizing effective readings, PowerPoints, podcasts, videos, and images for the course and modules.

Table 3 summarized the best practices to decrease extraneous cognitive load.

Table 3. *Best Practices to Decrease Extraneous Cognitive Load*

Cognitive Load	Design	Best Practices
Decreasing Extraneous Cognitive Load	Course Content Design	Utilizing the Built-in Features in the CLMS - Discussion feature - Assignments - Quizzes - Video feedback Limiting to using external webpages that ask for overly complex e-learning tools
	Course Structure Design	Implementing Consistency - Creating consistent module formats - Creating same due dates - Setting the same feedback methods and time in the communication plan - Limiting to extra clicks on webpages

Table 4 summarized the best practices to increase germane cognitive load.

Table 4. *Best Practices to Increase Germane Cognitive Load*

Cognitive Load	Design	Best Practices
Increasing Germane Cognitive Load	Course Content Design	Utilizing the Bloom's Taxonomy - Increasing thinking ranking skills/activities - Providing collaborative opportunities
		Creating More Autonomous and Collaborative Learning Activities - Utilizing a variety of multimedia (e.g., podcasts, PowerPoints, readings, videos, or images) to meet different learning styles. - Creating different learning activities (e.g., small research, discussion threads, group work discussion topics, group work projects, or peer reviews) - Creating engaging lectures (e.g., pop quizzes in the lectures)
	Course Structure Design	Effectively combining Various Multimedia
		Implementing Consistency

Implication

The research was bound in the qualitative paradigm that involved collecting data from interviews, observations, and documents. The participants were selected based on the purposeful sampling technique. The participants in the research were professors who taught online courses in the CLMS at the university level and had experience in monitoring students' cognitive load in online courses.

At the same time, there are three implications. The first implication is that the research findings can be transferred to the similar online teaching contexts where online courses are designed, developed, and delivered in a learning management system like Canvas for the university level. Findings can provide instructors best practices to control students' cognitive load through online course content design and online course structure design. Secondly, the findings can be transferred to the online educational environment where a learning management system is not available for some reasons. Instructors can utilize the suggested best practices to design the online course content and online course structure in a social media site, such as Edmodo, EduCreations, WordPress, or PbWorks. Finally, any minor change to online course content design and course structure design matters for learners. Teaching is an art. Any dedicated teaching creativity and application to online courses fosters students learning achievements.

Conclusion

It is true that online courses have been booming in the country, and more online courses have been offered at a university in Midwest Iowa yearly. Designing, developing, and delivering online courses effectively require instructors a lot of effort, time, and dedication. How to control cognitive load in online course content design and course structure design for students plays an important factor to maximize student learning achievement.

The research findings provided best practices for instructors to monitor students' cognitive loads in online courses. The findings aligned with the cognitive load theory in the literature review. The best practices in monitoring cognitive load in the research contributed the literature. The participants in the research supported that online course content design and online course structure design had strong impacts on students' cognitive load.

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