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Effects of degree of segmentation and learner disposition on multimedia learning

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Abstract

The construction of asynchronous learning environments often involves the creation of self-paced multimedia instructional episodes that provide the learner with control over the pacing of instruction (segmentation); however, does the amount of segmentation impact learning? This study explored the effects of the degree of segmentation on recall and application of new knowledge and the nature of learner dispositions toward segmentation. Undergraduate students ($n = 212$) were randomly assigned to engage in a 9-minute multimedia tutorial (ie, instructionally designed video-based presentation) addressing historical inquiry that was divided into 1, 7, 14 or 28 segments (degree of segmentation) where students had control over when each segment began via a "Continue" button. Students' dispositions toward the segmentation—helped learning, made learning easier, made learning confusing, was annoying or seemed appropriate—were also measured. Results indicated that increased segmentation facilitated recall and application; however, learners perceived a high degree of segmentation (28 segments) more negatively. Overall, these results indicate that increased segmentation within a multimedia instructional environment has a positive influence on recall and application, regardless of the learner's disposition toward the segmentation.

Introduction

Recent research demonstrates the value of learning in multimedia instructional environments (eg, Sosa, Berger, Saw & Mary, 2011) and the positive impact of segmentation on learning (eg, Hasler, Kersten & Sweller, 2007; Mayer, Dow & Mayer, 2003), where segmentation represents provision of control over the pacing of instruction. Segmentation has been hypothesized to reduce cognitive load, thus freeing cognitive resources for encoding new knowledge (Lusk *et al*, 2009; Tabbers & de Koeijer, 2010). That said, research on the use of segmentation has not been conclusive, with some studies resulting in positive learning outcomes (eg, Doolittle, 2010; Hassanabadi, Robatjazi & Savoji, 2011) and others resulting in neutral or negative learning outcomes, sometimes depending on the individual characteristics of each student (eg, Spanjers, Wouters, van Gog & van Merriënboer, 2011; Steinberg, 1989) or mode of learning outcome (eg, Doolittle, 2010; Mayer & Chandler, 2001). One aspect of segmentation that has not been

Practitioner Notes

What is already known about the topic

- Instructionally, too much information presented too quickly can exceed the learner's cognitive capacity and result in cognitive overload.
- One design solution is segmentation, the breaking of instruction into segments to provide learner control over the pace of instruction.
- Segmentation allows learners the opportunity to process information before continuing to the next learning task, allowing for deeper levels of learning.
- While segmentation has been demonstrated to positively impact student learning, the effect of the degree of segmentation, number of segments, has not been examined.

What this paper adds

- The degree of segmentation had a positive effect on learning such that a larger degree of segmentation led to increased recall and application.
- Learners' dispositions toward segmentation were generally positive; segmentation was perceived to help learning and made learning easier.
- A large degree of segmentation, however, while perceived as helping learning and making learning easier, was also perceived as annoying.

Implications for practice and/or policy

- Segmentation facilitates recall and application, and more segmentation leads to more learning.
- Learners see the value in segmenting as an instructional strategy for enhancing their learning.
- Learners may perceive an instructional strategy negatively, even though the strategy is effectively enhancing their learning.
- In instructional environments that utilize video for content engagement (eg, massive open online courses and flipping), high levels of segmentation should be used to facilitate student learning.

examined is the effect that the degree of segmentation—the number of segments into which an instructional unit is divided—has on learning. Further, although some research has examined the effect of overall control of instruction on student disposition toward learning, little is known regarding the effect of segmentation on learner disposition.

Theoretical framework

Segmentation principle

Mayer (2005) warned that when too much essential information is presented at a pace that is too quick, the instruction could exceed the learner's cognitive capacity and result in cognitive overload (eg, Hassanabadi *et al*, 2011; Mayer & Chandler, 2001). When this happens, the learner cannot process the necessary information and learning outcomes suffer. One design solution used in multimedia instruction to avoid essential overload is segmentation—the breaking of instruction into segments to provide learners with a *moderate* amount of control over the pace of the instruction through a "Continue" button. Segmentation allows learners the opportunity to fully process finite chunks of information before they continue on to the next learning task, allowing for deeper learning (Evans & Gibbons, 2007; Hasler *et al*, 2007; Mayer *et al*, 2003; Tabbers & de Koeijer, 2010).

Researchers have reported improvements in student performance when segmentation was incorporated into instructionally designed video-based presentations or tutorials (eg, Hasler *et al*, 2007; Mayer & Chandler, 2001; Tabbers & de Koeijer, 2010). Examining the effect of engaging in either segmented instruction (SI) or non-segmented instruction (NSI) of an online tutorial, Lusk *et al* (2009) found that students in the SI group scored significantly higher on knowledge acquisition and strategy application than students in the NSI group. Mayer and Chandler (2001) and Mayer *et al* (2003) found that students who engaged in SI rather than NSI performed significantly better on transfer and problem-solving tasks. Similarly, Evans and Gibbons (2007) and Tabbers and de Koeijer (2010) found that participants using SI performed better on a problem-solving test than those using program-paced instruction. Hasler *et al* (2007) found that participants who were provided SI demonstrated higher test performance and lower cognitive load than an NSI group, which was especially true for the more difficult test questions. Finally, Cheon, Crooks and Chung (2014) found that while segmenting increased students' recall and transfer of a short multimedia tutorial, active segmenting, where students answered two cued-recall questions during segmentation pauses, outperformed students who engaged in passive segmentation, where students simply reflected during segmentation pauses.

Perceptions of segmentation

While there are no current findings regarding student disposition toward multimedia segmentation, findings pertaining to learner control—"design features . . . that enable learners to choose freely the path, rate, content, and nature of feedback in instruction" (Reeves, 1993, p. 40)—have indicated a positive relationship between learner control and attitude (eg, Milheim, 1989). Specifically, students expressed greater satisfaction when they were provided control over activity selection (Vandewaetere & Clarebout, 2011), example selection (Ross, Morrison & O'Dell, 1989) and pacing of the content (Chou & Liu, 2005). Mayer (2005) and Lawless and Brown (1997) argued that learner control can reduce cognitive load, increase engagement, help students develop into more expert learners and improve learning outcomes.

While some research has found a positive relationship between learner control and disposition, very little is known regarding segmentation specifically and learner disposition. Research regarding learner control and disposition has suggested positive implications, which indicate students with SI, a form of learner control, may be likewise disposed. Few, if any, studies have investigated the effect of varying degrees of segmentation and whether a greater number of segments can impact disposition and/or performance. Although research is limited regarding effect of differing degrees of segmentation, the positive outcomes of previous segmentation research suggest that a greater degree of segmentation would be predictive of greater learning. The purposes of this study were to examine (1) if the degree of segmentation, as determined by the number of segments, affected students' knowledge recall and strategy application; (2) if the degree of segmentation affected the length of time it took students to complete the tutorial (tutorial engagement time); and (3) if students' dispositions toward segmentation were affected by the degree of segmentation.

Methodology

Participants

The participants were 212 undergraduate students (103 males and 109 females) with a mean age of 20.1 years (1.64 standard deviation). Participants included 21 freshmen, 83 sophomores, 38 juniors and 70 seniors. All participants were nonmajor undergraduate students enrolled in a lower-level general health course at a large Southeastern research university. Each student received course credit for participation and was randomly assigned to one of four segmentation groups. The four segmentation groups were formed according to students' engagement with a historical inquiry multimedia tutorial (ie, instructionally designed video-based presentation) that was divided into 1, 7, 14 or 28 segments addressing the four historical inquiry processes of summarizing, contextualizing, inferring and monitoring; thus, the tutorial is termed SCIM and the groups SCIM1, SCIM7, SCIM14 and SCIM28 reflect the number of segments. The random assignment to groups yielded sample sizes of SCIM1 ($n = 58$), SCIM7 ($n = 50$), SCIM14 ($n = 50$) and SCIM28 ($n = 54$).

Materials and apparatus

Historical inquiry tutorial

The SCIM historical inquiry multimedia tutorial, an instructionally designed video-based presentation, was (1) 1120 words and 9 minutes (540 seconds) in length; (2) based on animated images with concurrent narration; (3) created using Adobe's Flash™; and (4) focused on both historical inquiry, generally, and the SCIM strategy for historical inquiry, specifically (see Hicks & Doolittle, 2008). The first section of the tutorial discussed the general historical inquiry cycle including the asking of *historical questions*, the gathering of *historical sources*, the analyzing of historical sources to yield *historical evidence* and the creating of *historical interpretations* based on the resultant historical evidence that addresses the original historical questions.

The second section of the tutorial described the SCIM strategy for historical inquiry. The SCIM strategy consists of analyzing a specific source, such as a letter, by (1) first *summarizing* the apparent and observable evidence; then (2) *contextualizing* the source within the time and place in which the source was created; then (3) *inferring* from the source conclusions that lie beyond the source; and finally, (4) *monitoring* one's own thoughts for outstanding questions, needs for additional information beyond the source and the relevance of the source to the guiding historical questions. Within each of the four phases—summarizing, contextualizing, inferring and monitoring—there exists a series of four analyzing questions that focus the learner's attention on salient attributes of the source (eg, letter) under study; for example, an analyzing question for the summarizing phase is: Who are the author and audience of the source?

This 9-minute multimedia tutorial was then modified to construct the four treatment groups: SCIM1, SCIM7, SCIM14 and SCIM28. The SCIM1 version of the tutorial simply played from beginning to end with no interruptions or opportunities to stop/continue. The remaining three versions of the tutorial were subdivided into 7, 14 or 28 segments (ie, SCIM7, SCIM14 or SCIM28, respectively) based on where in the tutorial it made conceptual sense to insert a "segment control point." A segment control point consisted of the tutorial stopping and a "Continue" button appearing at the bottom right of the screen. Once the participant clicked on the "Continue" button, the tutorial's next segment would play until the next segment control point. This process provided the users with a moderate level of control over the pacing of instruction or the time spent on a given section before moving forward. Participants did not have control over stopping and rewinding the content at will. The tutorial was preprogrammed with mandatory stops in this way because students do not always utilize control tools provided in multimedia learning environments (Azevedo, Guthrie & Seibert, 2004; Proske, Narciss & Körndle, 2007). Further, provision of too much control has been associated with fewer learning gains (Aleven & Koedinger, 2000; Mayer, 2004), especially in novice learners and those who lack sufficient strategies (Kirschner, Sweller & Clark, 2006; Rittle-Johnson, 2006).

Finally, the segmented versions of the tutorial were designed to incorporate control points (ie, "Continue" button) at key conceptual intervals. Each version contained a different number of segments resulting in various segment lengths. The SCIM7 version of the tutorial was subdivided into 7 segments with an average segment length of 77.1 seconds (range = 45–85 seconds), the SCIM14 version of the tutorial was subdivided into 14 segments with an average segment length of 38.5 seconds (range = 30–54 seconds) and the SCIM28 version was subdivided into 28 segments with an average segment length of 19.2 seconds (range = 6–46 seconds). Other than the segmenting, the content of each version of the tutorial was identical to assess the effect of segmentation on recall and application.

Recall test and scoring

Participants' recall of the SCIM strategy was assessed using a single open-ended question: "Please provide an explanation of historical inquiry and the SCIM strategy." Participants completed this question by typing their responses into a text box on the computer screen. Two trained scorers evaluated each response (interrater reliability, $r = .92$) and awarded a maximum of 12 points. Specifically, a response received a maximum of four points for defining/describing the four stages of the general historical inquiry cycle, one point each for defining/describing historical questions, historical sources, historical evidence and historical interpretations. In addition, a response received a maximum of eight points for defining the four SCIM phases, two points each for summarizing, contextualizing, inferring and monitoring—one point was earned for a basic definition of the phase and one point for mentioning two or more of the analyzing questions.

Application test and scoring

To assess participants' ability to apply the SCIM strategy, participants read a historical letter and then typed a historical interpretation in a text box provided on the computer screen under the letter. The letter to be interpreted addressed the plight of a child during the Depression: "Use the letter below to help you in answering the following question: What does this source reveal about the life of a child during the Depression?" Two trained scorers evaluated each response (interrater reliability, $r = .81$) and awarded a maximum of 16 points. Each response was scored such that four points were possible for each of the four SCIM phases. Specifically, in describing the summarizing phase, participants received one point each for addressing the letter's (1) subject, (2) author, (3) audience and (4) specific details. In addition, in describing the contextualizing phase, participants received one point each for including (1) when, (2) where and (3) why the letter was written, as well as (4) what was happening within the immediate and/or broader contexts in which the letter was written. While describing the inferring phase, participants received two points each for (1) including in the response explicit and/or implicit inferences and (2) inferences based on omissions within the letter. Finally, while describing the monitoring phase, participants received two points each for including in the response (1) specific needs for additional information beyond the letter itself and (2) the usefulness of the source in answering the historical question.

Tutorial engagement time

Tutorial engagement time was the time participants took to view and engage the appropriate tutorial given their group assignment (ie, SCIM1, SCIM7, SCIM14 or SCIM28). Tutorial engagement time began when participants accessed the tutorial page. When a participant accessed the tutorial page, the tutorial started automatically, as did the tutorial engagement timer (the timer was not visible and time was kept by the computer). When each tutorial segment ended, the participant was prompted to press "Continue" to proceed (the "Continue" button was not visible until the tutorial segment ended). The tutorial segment engagement time ended when the participant clicked this "Continue" button. Because the final "Continue" button did not appear until after the last tutorial segment had finished, the minimum engagement time was 9 minutes or 540 seconds.

Segmentation disposition survey

The segmentation disposition survey consisted of five items addressing the participants' dispositions (ie, attitudes and values) related to the process of segmentation. The five items were (1) "The number of segments helped me learn the SCIM strategy better"; (2) "The number of segments made learning the SCIM strategy easier"; (3) "The number of segments made learning the SCIM strategy confusing"; (4) "The number of segments was annoying"; and (5) "The number of segments seemed appropriate." Participants responded to each statement based on the following scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *somewhat disagree*, 4 = *neutral*, 5 = *somewhat agree*, 6 = *agree* and 7 = *strongly agree*.

Procedure

The participants completed all data collection and media presentations on Macbook wireless laptop computers. Participants were tested in groups of three to eight. Participants were instructed to complete a demographics questionnaire and once all participants completed the questionnaire, they were instructed that they were to engage the subsequent tutorial and to press the "Continue" button to begin. When students pressed the "Continue" button, they were provided the appropriate version of the SCIM historical inquiry multimedia tutorial based on each student's random assignment to a specific treatment group (ie, SCIM1, SCIM7, SCIM14 or SCIM28). Once the tutorial ended, they were informed to press the "Continue" button to proceed. Participants were then asked to complete the Segmentation Disposition Survey and await further instructions. Upon all participants' completion of the survey, they were asked to complete the recall task (approximately 5 minutes). Upon all participants' completion of the recall task, they were finally asked to complete the strategy application task (approximately 10 minutes).

Results

This study was designed to explore the effects of the degree of segmentation on recall and application and the nature of learner dispositions toward the degree of segmentation. All post hoc comparisons involved Tukey analyses with an alpha criterion of .05 and all effect size calculations involved Cohen's d (see Cohen, 1988). Cohen's d effect sizes are interpreted as small ($d = 0.20$), medium ($d = 0.50$) and large ($d = 0.80$).

Effects of the degree of segmentation

Recall

A one-way analysis of variance (ANOVA) (ie, SCIM1, SCIM7, SCIM14 and SCIM28) revealed statistically significant differences in recall based on the degree of segmentation (see Table 1), $F(3, 211) = 14.72$, $p < .01$. Specifically, there was a monotonic increase in mean recall from SCIM1 through SCIM28. Tukey post hoc analyses revealed no statistically significant differences between adjacent pairs of means (SCIM1 vs. SCIM7, SCIM7 vs. SCIM14 and SCIM14 vs. SCIM28); however, Tukey post hoc analyses did reveal significant differences between SCIM1 and SCIM14 ($d = 0.76$), SCIM1 and SCIM 28 ($d = 1.25$) and SCIM7 and SCIM28 ($d = 0.78$). These results

Table 1: Means (M) (and standard deviations [SDs]) for recall and application scores, and engagement time by degree of segmentation

	Degree of segmentation			
	SCIM1 M (SD)	*SCIM7* M (SD)	*SCIM14* M (SD)	*SCIM28* M (SD)
Recall	004.10 (2.11)$_a$	005.18 (2.18)$_{a,b}$	006.00 (2.78)$_{b,c}$	007.06 (2.60)$_c$
Application	003.88 (1.88)$_a$	004.36 (2.82)$_a$	005.38 (2.40)$_b$	006.48 (2.12)$_c$
Engagement time	547.30 (3.60)$_a$	603.81 (52.0)$_b$	645.93 (63.2)$_c$	650.06 (64.3)$_c$

Note. SCIM1 $n = 58$; SCIM7 $n = 50$; SCIM14 $n = 50$; SCIM28 $n = 54$. Max recall score = 12. Max application score = 16. Engagement time is in seconds. Means in each row sharing subscripts do not differ significantly at $p < .05$.

indicate that the degree of segmentation had a medium to large positive effect on recall such that a larger degree of segmentation led to increased recall. That said, these results also indicate that the increase in the degree of segmentation needs to be considerable in order to result in significant changes in recall.

Application

Further, a one-way ANOVA revealed statistically significant differences in application based on the degree of segmentation (see Table 1), $F(3, 208) = 13.59$, $p < .01$. Again, there was a monotonic increase in mean application from SCIM1 through SCIM28. Tukey post hoc analyses revealed no statistically significant difference between the means of SCIM1 versus SCIM7, but statistically significant differences between all other pairwise comparisons with effect sizes (d) ranging from 0.38 to 1.29. These results indicate that the degree of segmentation had a medium to large positive effect on application such that a larger degree of segmentation led to increased application.

Engagement time

In addition, a one-way ANOVA was used to assess the impact of segmentation on participants' engagement time, revealing statistically significant differences in tutorial engagement time based on the degree of segmentation (see Table 1), $F(3, 211) = 47.91$, $p < .01$. There was a monotonic increase in mean engagement time from SCIM1 through SCIM28. Tukey post hoc analyses revealed statistically significant differences between all pairwise comparisons, with effect sizes (d) ranging from 0.73 to 2.25, with the exception of SCIM14 versus SCIM28, which was not statistically significantly different. These results indicate that participants took more time engaging with the tutorial as the degree of segmentation increased, but only to a point, as there was no significant increase from SCIM14 to SCIM28.

Finally, in examining the effects of segmentation on recall, application and engagement time, two correlations were conducted. Both the recall versus engagement time ($r = .46$, $p < .01$) and application versus engagement time ($r = .34$, $p < .01$) were statistically significant. These results indicate a positive relationship (not causality) between tutorial engagement time and recall/application performance—the more time participants spent engaging with the tutorial, the better they recalled and applied the SCIM strategy.

Learner dispositions toward the degree of segmentation

A multivariate analysis of variance (MANOVA) was used to examine the effects of the degree of segmentation on learner disposition (see Table 2) revealing a significant effect, $F(15, 618) = 5.83$, $d = 0.84$, $p < .01$ (Pillai's trace). Based on the significant MANOVA, an ANOVA for each

Table 2: Means (M) (and standard deviations [SDs]) for disposition questions by degree of segmentation

	Segment length			
Segments	*SCIM1* M (SD)	*SCIM7* M (SD)	*SCIM14* M (SD)	*SCIM28* M (SD)
Made learning better	$4.53\ (1.51)_a$	$5.08\ (1.29)_a$	$5.12\ (1.28)_a$	$2.93\ (1.25)_b$
Made learning easier	$4.59\ (1.40)_a$	$4.92\ (1.25)_a$	$4.94\ (1.16)_a$	$3.50\ (1.48)_b$
Made learning confusing	$3.53\ (1.48)_a$	$3.32\ (1.49)_a$	$3.72\ (1.38)_a$	$3.72\ (1.65)_a$
Were annoying	$4.12\ (1.83)_a$	$4.34\ (1.63)_a$	$4.52\ (1.81)_a$	$6.00\ (1.08)_b$
Seemed appropriate	$4.26\ (1.58)_a$	$4.24\ (1.53)_a$	$4.26\ (1.39)_a$	$3.19\ (1.38)_b$

Note. SCIM1 $n = 58$; SCIM7 $n = 50$; SCIM14 $n = 50$; SCIM28 $n = 54$. Max disposition score = 7. Means in each row sharing subscripts do not differ significantly at $p < .05$.

disposition question across the four levels of the degree of segmentation was computed. Four of the five disposition-based ANOVAs were significant: (1) *made learning better*, $F(3, 208) = 30.7$, $d = 1.30$, $p < .01$; (2) *made learning easier*, $F(3, 208) = 24.2$, $d = 0.87$, $p < .01$; (3) *were annoying*, $F(3, 208) = 39.4$, $d = 0.90$, $p < .01$; and (4) *seemed appropriate*, $F(3, 208) = 15.30$, $d = 0.62$, $p < .01$; while *made learning confusing* was not significant, $F(3, 208) = 081$, $d = 0.22$, $p = .48$.

In each of the cases where the disposition-based ANOVA was significant, Tukey post hoc analyses revealed that participants rated SCIM28 for each disposition significantly lower ($p < .001$) than SCIM14, SCIM7 and SCIM1. Effect sizes comparing SCIM28 with SCIM14, SCIM7 and SCIM1 across these four dispositions ranged from 0.72 to 1.74, with a median effect size of 1.15. These results indicate that while students' dispositions toward segmentation were generally positive, negative dispositions toward extensive segmentation were considerable.

Discussion

The present study investigated the effect of degree of segmentation in multimedia instruction on knowledge recall, strategy application and learner disposition. Our results indicate that segmentation facilitates recall and application, and that more segmentation leads to greater time engagement with the tutorial and more learning. Our results are consistent with the premises of cognitive load theory, which suggests that frequent pauses in instructional pace permits processing time such that limited cognitive resources can be used more efficiently and excessive cognitive load avoided (Mayer & Moreno, 2003; Spanjers, van Gog, Wouters & van Merriënboer, 2012; Sweller & Chandler, 1994). Processing too much information simultaneously, such as when instruction is quickly paced without pauses, can impair learning (Sweller & Chandler, 1994). Pauses are particularly important for tasks that are more cognitively demanding, and incorporating pauses into instruction can lead to increased task performance (Hasler *et al*, 2007; Spanjers *et al*, 2012). The results of the present study further align with research concerning instructional tutorial length. Research suggests that shorter tutorials promote engagement and, in turn, learning, while longer tutorials result in significantly decreased engagement (Guo, Kim & Rubin, 2014; Kim *et al*, 2014).

Our findings indicate that students view segmentation positively up to a point (SCIM28) and that segmentation generally is not considered confusing. At SCIM28, our participants perceived that segmentation did not facilitate their learning and found the increased level of pauses to be annoying and inappropriate. Although participants in SCIM28 had negative perceptions of segmentation, the increased degree of segmentation still benefitted their learning. Holding negative perceptions in contrast to positive learning outcomes is consistent with existing research, which has proposed that learners do not always favor the instructional practices that most positively affect their learning (Milheim, 1989; Ross *et al*, 1989; Steinberg, 1989). For example, previous research suggests that students do not always select the most appropriate study strategies when given several options (Davis & Annis, 1978; Senko & Miles, 2008), they often do not accurately judge the type and amount of help required for success (Aleven & Koedinger, 2000) and their personal interests can interfere with learning (Harp & Mayer, 1998; Senko & Miles, 2008). Further, some studies have reported little correlation between preference toward instruction and performance (eg, Kettanurak, Ramamurthy & Haseman, 2001).

Overall, our findings have important implications for multimedia instructional design. As multimedia-based tasks become more prevalent in instruction (Clark & Mayer, 2003), effective learner-centered design standards need to be determined and employed. Clark and Mayer (2003) proposed that "failure to accommodate human learning processes" (p. 24) is a primary pitfall preventing e-learning from reaching its potential. "The challenge in e-learning, as in any learning program, is to build lessons in ways that are compatible with human learning processes. To be effective, instructional methods must . . . foster the psychological events necessary for learning" (Clark & Mayer, 2003, p. 30). The present findings can guide instructional design, thus bridging research, theory and practice in order to support student learning and disposition in multimedia learning environments.

This bridging of research, theory and practice is germane to the current adoption of flipping and massive open online course (MOOC) pedagogies. The "flipped classroom" often relies heavily on replacing face-to-face lectures, case studies, lab introductions or general content presentations with engagement in typically non-segmented pre-class video tutorials (Bergmann & Sams, 2012; Krebs, Holman, Bodnar, Weinberg & Vogl, 2014), while MOOCs tend to adopt an online approach that relies heavily on the use of non-segmented video-based content presentation (DeBoer, Ho, Stup & Breslow, 2014; Waldrop, 2013), including university/teacher-created videos (eg, MIT OpenCourseWare, YouTube) or institutionally created videos (eg, Kahn Academy, TED-Ed). The current research indicates that these non-segmented videos should be segmented into several instructional sections.

The present study contributes themes largely unexplored in the current literature and proposes that more segmentation in multimedia learning environments can reduce cognitive load and foster learning. While the highest degree of segmentation measured had some limited negative implications on affect, student learning was supported more at that level than at all other degrees of segmentation. That said, most multimedia design principles are more nuanced than "more segmentation leads to more learning." Thus, it will be important to develop a broader understanding of degree of segmentation and student disposition, including investigating additional degrees of segmentation, differences in the nature of the learning task, impact on cognitive load, overall length of the instructional video and students' prior experiences and learning.

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