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# Examples and the facilitation of student learning: should instructors provide examples or should students generate their own?

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**ABSTRACT**

This study examined learning differences for students who were given instructor-provided examples during a lesson compared with student-generated examples. In an experiment, 348 students were exposed to an online lesson about fear appeals and were randomly assigned to either a condition where (a) examples of key concepts were provided by the instructor, (b) students were asked to provide their own hypothetical examples of key concepts, or (c) students were asked to provide their own personal examples of key concepts. Data were analyzed to examine differences in students' test scores while controlling for the impact of their familiarity with the material and grade point averages. Results revealed that, compared with students exposed to instructor-provided examples, students who generated their own scored lower on a test of recall and application. This outcome was modeled using path analysis specifying a moderated serial mediation effect. Specifically, instructor-provided examples created higher lesson clarity for students which helped them organize the lesson material into a more coherent mental model and, subsequently, score higher on the test. The serial indirect effect of example type on learning occurred most prominently for students who were disinterested in the lesson material.

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A major component of the job requirements for university professors includes teaching students in various areas of expertise (Hadre & Cox, 2009). Considering this goal, instructional communication scholars and educational psychologists have worked diligently to identify behaviors and practices that facilitate this process. Though a plethora of suggestions could be made to help individuals who wish to teach others (e.g., Bolkan, 2017c; Mayer, 2014; Sweller, Ayres, & Kalyuga, 2011), teaching clearly is particularly critical for students' academic success (Murray, 1983; Titsworth, Mazer, Goodboy, Bolkan, & Myers, 2015). To this point, instructor clarity has been associated with a host of positive student outcomes including enhanced interest (Mazer, 2013a, 2013b), positive affect (Titsworth et al., 2015), and increased learning (Bolkan, Goodboy, & Kelsey, 2016; Seidel, Rimmele, & Prenzel, 2005). In fact, clarity is so integral to instructional effectiveness

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that Chesebro (2003) claims "the ability to teach clearly so that students can understand course material is fundamental to teaching" (p. 135).

Taking into account the importance of instructor clarity, individuals who wish to teach clearly might inquire about the behaviors associated with clear teaching. Bolkan (2017a) provides some guidance noting that clarity in the classroom may be operationalized through five correlated behavioral components. These components include (dis)fluency (i.e., the ability to communicate in a simple, straightforward manner), working memory overload (i.e., presenting information within the bounds of students' limited working memory capacities), interaction (i.e., working with students to ensure comprehension), coherence (i.e., removing superfluous information from course lessons), and structure (i.e., organizing information into specific, manageable content blocks). The importance of detailing the various components of clarity is evident when noting their differential/individual impact on student learning outcomes (Bolkan, 2017a). For example, recent studies on student learning have demonstrated that examining the specific concepts of structure (Bolkan, 2017b), coherence (Bolkan, Griffin, & Goodboy, 2018), and working memory overload (Bolkan 2019) can be fruitful and has led to important recommendations for instructional practitioners.

Though there are several dimensions of clarity, the current investigation focuses on disfluency and its impact on student learning. In particular, disfluency refers to "instructors who have a difficult time explaining class concepts in a simple manner, who cannot create examples to explain course concepts, and who deliver course lessons in a convoluted fashion" (Bolkan, 2017b, p. 13). As a part of the fluency dimension, the provision of examples appears to be a particularly important aspect of clear teaching. In support of this assertion, several researchers have noted the value of using examples to help students learn course material (Elio & Anderson, 1981; LeFevre & Dixon, 1986; Sweller et al., 2011). Although using examples in class has the potential to benefit student learning outcomes, classroom examples might stem from a variety of sources. Therefore, instructors might sensibly wonder who should supply examples to best facilitate student success. More specifically, who is the better source of learning examples in class: instructors or students themselves? Because it is not evident who should provide these, the current study was designed to investigate whether instructor-provided or student-generated examples would lead to enhanced learning outcomes for students, and why one source of learning might be better for students than the other.

## Role of examples in information processing

### *Dual coding theory*

One of the reasons why examples might benefit student learning stems from dual coding theory (Sadoski & Paivo, 2013). According to dual coding theory, humans have two information-processing systems including one that is sensitive to words and another that is sensitive to images. As the theory suggests, compared with instructors who focus on one system, instructors who utilize both information-processing systems to teach their course lessons create a richer educational environment because they utilize a broader range of students' learning capabilities by activating additional levels of meaning (Sadoski & Paivo, 2013).

Regarding the two processing systems, proponents of dual coding theory endorse the provision of both concrete and abstract information because doing so creates more opportunity for receivers to encode learning material and to make connections between the two (Sadoski & Paivo, 2013). Ultimately, the provision of concrete information has the potential to make abstract learning material easier to comprehend because concrete information is likely to to evoke mental imagery that complements information being processed in the verbal system (Sadoski & Paivo, 2013). Concerning concrete representations, these can be provided when instructors communicate contextualized examples that embody lesson material in a manner that is connected to physical or perceptually rich situations (Goldstone & Son, 2005). That said, when teaching course lessons, instructors who provide concrete examples make information clearer because concrete information evokes mental imagery (Sadoski, 2001), provides a context that contributes to meaning, and makes information both easier to understand and more memorable (Sadoski & Paivo, 2013).

### *Examples, clarity, and organization*

As we argued above, concrete examples in education have the potential to make course material clearer, but why should clear teaching benefit student learning? One answer might include the ability for clear instruction to aid essential information-processing activities (Bolkan, 2016, 2019). According to Mayer's (2009, 2014) cognitive theory of multimedia learning (CTML), there are three activities that are essential to learning. The first activity involves paying attention to information presented or produced by an instructor (Mayer, 2009). This activity is important because students are unlikely to learn information they do not focus on. The second activity involves organizing information to form a coherent model. Organization is at the heart of student understanding and involves structuring lessons in the form of classification, comparison, or generalization (for example). Finally, the third activity involves integration which entails linking newly modeled mental structures to students' prior knowledge. According to Mayer, students must be effective in all three learning activities if they are to master material presented in their lessons.

Although students might enter their classrooms with the potential to engage in the three activities that lead to learning, an important caveat to consider is that students do not have unlimited cognitive capabilities. Having said that, when information is unclear, instructors "shift learners' attention from deeply processing information to cognitive processes that do not aid in learning, such as trying to make sense out of a confusing lesson or trying to determine what information is necessary for learning" (Bolkan, 2016, p. 153). Therefore, instructional interventions that can reduce students' cognitive burden aid their ability to engage in the three essential learning activities (Mayer, 2009; Plass, Moreno, & Brunken, 2010; Sweller et al., 2011). To this point, instructional contexts that are clear have been shown to reduce students cognitive load (Bolkan, 2017a) and enhance students' ability to elaborate on learning material in a manner that ultimately leads to improved learning outcomes (Bolkan, 2016). In other words, compared with students exposed to an unclear lesson, students who are exposed to clear teaching are less likely to be preoccupied with unnecessary information processing and are therefore more likely to have the wherewithal to engage in activities that are essential to learning (see Bolkan, 2019).

Thus, as it relates to the current study, we predict that perceptions of clear teaching will be positively associated with students' ability to make sense out of their lessons by organizing them in a coherent manner. Essentially, clear instruction should reduce extraneous processing, free up students' cognitive resources, and allow them to form coherent representations of their lessons. Therefore, considering concrete examples have been shown to aid in student comprehension (Sadoski, Goetz, & Rodriguez, 2000), it could be plausible that their influence stems from the ability to produce clear lessons, which subsequently helps learners organize learning material and form mental models of the lessons being taught (Sadoski & Paivo, 2013).

### *Examples in the classroom*

Researchers have long known that examples can enhance student learning (Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Elio & Anderson, 1981; Reed, Dempster, & Ettinger, 1985) and that the use of concrete illustrations might benefit students' abilities to both understand and retain information (Sadoski & Paivo, 2013). For instance, Reder, Charney, and Morgan (1986) found that when students were exposed to elaborated learning material, including examples, they worked more efficiently and accurately when solving problems and completing related tasks than students who were not. Ultimately, examples may benefit students through their impact on case-based reasoning where people arrive at solutions to new problems by reusing information from similar situations. Stated differently, during case-based reasoning, people use knowledge from previously experienced cases or examples and adapt this information to solve problems in new contexts (Aamodt & Plaza, 1994). Case-based reasoning is argued to be important in educational settings because cases help learners think about, explain, understand, and remember concepts more clearly (Jonassen & Hernandez-Serrano, 2002). Put simply, examples can be beneficial because they help students form schemas by abstracting principles that can be applied later, and also because they help students recognize problems that can be solved by using previously experienced solutions (Elio & Anderson, 1981).

Because examples can benefit student learning, Jonassen and Hernandez-Serrano (2002) argued that educators should include these (as opposed to relying solely on abstract principles) to frame learning scenarios and to aid in students' development of various problem solving skills. Having said that, the question remains: who should provide examples in the classroom? Should instructors provide these to students or should students be asked to generate examples themselves? Some researchers might conclude that instructor-provided illustrations are best because they reduce the information-processing burden for student learners (Sweller et al., 2011), or because they represent more accurate representations of the learning material (Reder et al., 1986). Conversely, others might conclude that student-generated examples should prove superior because students who construct their own learning material might be more engaged with their classroom lessons (Chi, 2009; Chi & Wiley, 2014) and therefore more likely to elaborate on newly acquired information (Fiorella & Mayer, 2016).

Importantly, Reder et al. (1986) concluded that the benefit of examples likely stems from their quality and relevance to the main points they support. That said, although scholars have demonstrated that people recall information better when it is linked to ideas they have created themselves (e.g., Bobrow & Bower, 1969), researchers have also found that students are not often effective when it comes to independently elaborating on course content (Dornisch, Sperling, & Zeruth, 2011; King, 1992). Thus, it is our supposition that instructor-provided examples may benefit students more than student-generated examples because instructor-provided examples are likely to represent a more accurate and therefore clearer picture of targeted educational principles. This is especially important considering that students are better able to use old problems to solve new ones when there is more overlap between the two (Reed et al., 1985). Because the quality of examples matters when it comes to learning, we argue that instructor-provided examples will positively impact student learning more than student-generated examples.

### *Hypothesis and serial mediation model*

Based on the information presented above, we predicted that instructor-provided examples should benefit student learning compared with student-generated examples. More specifically, we predicted that this outcome would be the result of students perceiving a lesson with instructor-provided examples to be clearer, and subsequently being able to organize information from this lesson in a coherent manner. As a result, we predicted that the more students were able to form coherent mental structures from a lesson, the better they would score on a subsequent test of this knowledge.

In this study, we chose to operationalize student-generated examples in two ways. According to researchers (e.g., King, 1992; Levin, 1988), one of the fundamental processes of learning involves making course information meaningful, which makes it easier to remember. A lesson's level of meaningfulness often stems from the connections that students are able to make between what they are learning and their existing knowledge/experiences. Although there are many ways for students to make their lessons more meaningful, this study focuses on how students explain an instructional lesson by creating examples of the learning material. That said, we chose to utilize two types of examples in this study: hypothetical and personal examples. Though both types of examples are related to students' base of knowledge, we tested the two conditions because personal examples might be more closely related to students' own experiences compared with hypothetical examples. Therefore, we chose to measure both types of student-generated examples to cover a range of meaningfulness as it pertains to students' course-related exemplars.

Moreover, because students' expertise has been shown to be an important factor related to their ability to process information (Kalyuga, 2014), we measured their familiarity with the material to control for its impact on the learning process. Similarly, because students' grade point averages (GPAs) have been shown to influence learning in experimental studies (e.g., Bolkan, 2019), we measured these as covariates to control for their influence as well. Finally, because students must be motivated to engage in the cognitive processes associated with learning (Fiorella & Mayer, 2016), we also measured student interest as a covariate to control for its influence. For the conceptual model testing our hypothesis, see Figure 1.

> H: After controlling for familiarity with the material, GPA, and interest, students will score higher on a test of retention and transfer when exposed to instructor-generated examples compared with students who are asked to generate their own examples. This outcome will be the result of a serial indirect effect occurring through perceived clarity and subsequently through students' ability to organize lesson information.

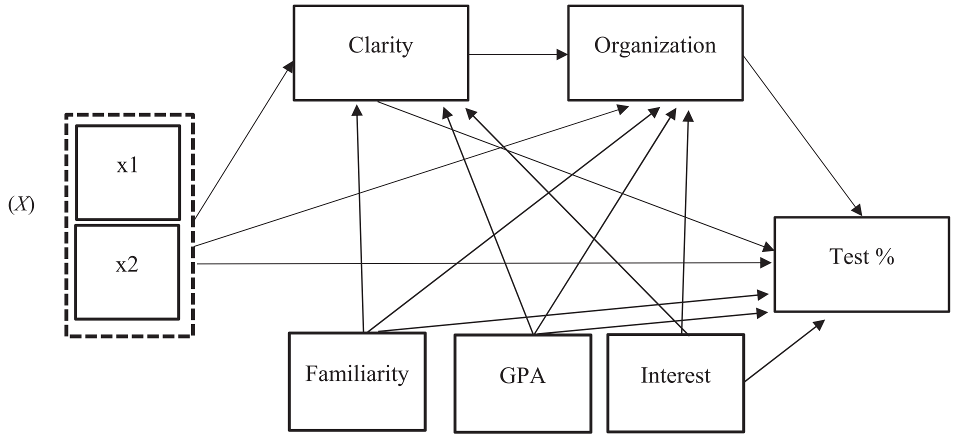


**Figure 1.** Hypothesized serial mediation model.

Note: For indicator-coded groups (x1 and x2), coefficients reflect mean differences in comparison with the referent group: instructor-generated examples. x1 = student-generated hypothetical examples; x2 = student-generated personal examples.

### Research questions and moderated serial mediation model

In addition to the hypothesis, we also sought to examine research questions regarding the moderating influence of interest in our model (see Figure 2). In the current study, we defined interest as a combination of personal and situational interest (Mitchell, 1993). Personal interest relates to individual preferences for learning material whereas situational interest originates from learning environments and occurs when material is relevant to students or captures students' attention. Having said the above, our research questions stemmed from scholarship indicating that students who are interested in their learning material tend to engage with course lessons in more meaningful ways compared with students who are uninterested (Hidi, 1990; Mazer, 2012; Schiefele, 2016).

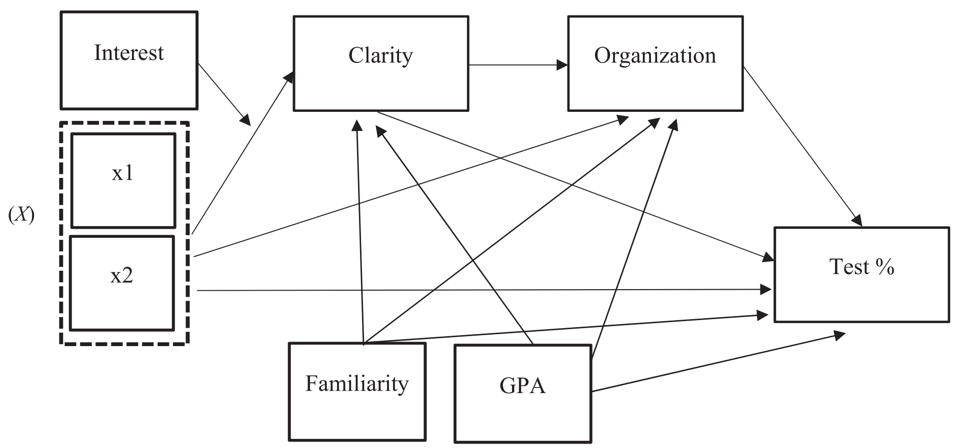


**Figure 2.** Hypothesized serial moderated mediation model.

Note: For indicator-coded groups (x1 and x2), coefficients reflect mean differences in comparison with the referent group: instructor-generated examples. x1 = student-generated hypothetical examples; x2 = student-generated personal examples.

Pertaining to students' classroom experiences, a lack of student interest can be a problem because when students are not interested in what they are learning, they are less likely to pay attention to their lessons and to be motivated to learn course material (Bolkan & Griffin, 2018). Moreover, less interested students are likely to experience studying their course lessons as more effortful (Hidi, 1990) and may be less likely to invest the resources necessary to learn course concepts (Shiefele, 2016). For example, as it pertains to thinking about their course lessons, Ozgungor and Guthrie (2004) claimed that interest leads to deeper information processing and argued that, compared with more interested students, less interested individuals are not motivated to expend the effort necessary to effectively process learning material. In support of this argument, Ozgungor and Guthrie found that instructional interventions focused on helping students elaborate course material benefited uninterested students more than it did interested students.

Considering the conclusions articulated above, we might wonder if less interested students would produce worse examples because these individuals may be less likely to exert the effort needed to link lesson material to new exemplars in a coherent manner. Having said the above, helping students elaborate on course material by providing examples might benefit uninterested students more than it does interested students because instructor-provided examples are likely to be of better quality compared with those generated by the former. To help investigate these ideas, the following research questions were posed:

RQ1: Is interest related to the accuracy of the examples students generate?

RQ2: Is the serial indirect effect in Hypothesis 1 moderated by the interaction between the experimental conditions and student interest as it pertains to clarity?

## Method

### *Participants and procedure*

After receiving approval from two institutional review boards, participants were recruited from students enrolled in both upper and lower division Communication Studies courses across two universities located on the West ($n = 148$) and East Coasts ($n = 200$). Participants were 348 undergraduate students (105 men, 242 women, one participant declined to state) with ages ranging from 18 to 67 years old ($M = 21.1$, $SD = 3.9$). Sixty-nine students reported being in their first year of college, 53 students were in their second year, 101 students were in their third year, 94 students were in their fourth year, and 31 students reported being in their fifth year or beyond. Students who agreed to take part in the study were provided with a link to an online survey where they were directed to read a short lesson on persuasion based on protection motivation theory (Rogers, 1975, 1983).

Participants were randomly assigned to one of three experimental conditions in this study. However, regardless of the condition, all participants read an identical lesson consisting of 613 words spread over four pages that they moved through at their own pace. Each condition described five concepts from a lesson on persuasion including threat (i.e., susceptibility and severity), coping (i.e., self-efficacy and response efficacy), and costs as they related to the use of fear appeals and subsequent human behavior.

The conditions in this study differed solely on the nature of examples generated to explain the five concepts noted above. The first condition ($n = 122$) consisted of instructor-provided examples. In contrast, the second condition ($n = 113$) asked students to produce their own hypothetical examples of the concepts. For instance, in the second condition students were told,

> Before moving on, think of a hypothetical example where a person might or might not feel a sense of threat due to susceptibility (or lack thereof). This example should not be based on personal experience, but should simply be something that could happen in life. Please write out that example below.

Similarly, students in the third condition ($n = 113$) were asked to come up with examples from their own lives to demonstrate each of the five concepts outlined in the lesson. For instance, the prompt in this condition was:

> Before moving on, think of an example from your own life where you might or might not have felt a sense of threat due to susceptibility (or lack thereof). This example should be based on personal experience. Please write out that example below.

Students who generated their own examples were given ample space to type out their responses in an open-ended text box (please refer to the Appendix for details regarding instructor-provided, student-generated hypothetical, and student-generated personal examples). After being exposed to one of the three conditions, students were directed to another part of the survey where they provided their responses to the instruments below.

### *Instrumentation*

Participants were exposed to several measures to assess their perceptions of lesson clarity, their ability to organize information from the lesson coherently, their interest in the topic, and their familiarity with the material. Specifically, lesson clarity was operationalized with three items adapted from Bolkan et al. (2016). These items include "The lesson was very clear," "The lesson made perfect sense," and "The lesson was very easy for me to understand." Response options ranged from (1) *strongly disagree* to (7) *strongly agree* ($M = 4.82$, $SD = 1.49$, $\alpha = .94$).

Students' ability to organize information was assessed using a five-item measure borrowed from Bolkan (2017b). This measure asks students the extent to which they agree or disagree with statements such as "I was able to organize the material presented in this lesson in a logical manner" and "I grasped how the various parts of this lesson worked jointly to form the ideas I was learning." Response options ranged from (1) *strongly disagree* to (7) *strongly agree* ($M = 5.00$, $SD = 1.25$, $\alpha = .94$).

The measure of student interest in the topic of the lesson was borrowed from Bolkan et al. (2018). This measure includes three items based on definitions of personal and situational interest (Bolkan & Griffin, 2018; Mitchell, 1993). Items in this measure include "The material presented was very interesting to me," "The lesson captured my attention," and "The lesson was exciting." Response options ranged from (1) *strongly disagree* to (7) *strongly agree* ($M = 4.35$, $SD = 1.52$, $\alpha = .92$).

To control for its influence on the results, familiarity with the lesson material was measured using three items from Bolkan et al. (2016). Items in this measure include "How familiar were you with this topic before today?" "How much did you already know about the subject being discussed?" and "To what extent had you been exposed to the material in this lesson in the past?” Response options ranged from (1) *not at all* to (7) *very much* ($M = 3.26$, $SD = 1.62$, $\alpha = .94$).

Previous research has demonstrated that students’ GPAs can influence their test results in studies of instructional interventions (e.g., Bolkan, 2019). Because this is the case, students were asked to report their GPAs to control for the influence of this variable on their learning. In this study, students’ self-reported GPAs ranged from 1.80 to 4.00 ($M = 3.28$, $SD = .46$).

Finally, learning in this study was operationalized as students’ ability to retain and apply information from the lesson provided (Anderson & Krathwohl, 2001). Specifically, to assess their ability to learn the lesson, students were asked to respond to an eight-item multiple-choice test of the material with four response options for each question. Generally, these items asked students to recall information from the lesson to and to apply this information to new, hypothetical scenarios. Correct answers were scored as 1 and incorrect answers were scored as 0. Students’ test scores were converted to percentages for ease of interpretation ($KR\text{-}20 = .61$, $M = 55.53$, $SD = 24.36$).

## Results

### *Hypothesis*

First, we examined the factor structure of our measures using confirmatory factor analysis with robust maximum likelihood estimation. Each of the indicators for clarity, organization, familiarity, and interest was predicted by latent variables associated with the respective indicators. Global fit statistics revealed that the proposed measurement model fit the data reasonably well: Satorra–Bentler scaled $\chi^2 = 158.36$, $df = 71$, $p < .01$, standardized root mean square (SRMR) = .03, comparative fit index (CFI) = .97, root mean square error of approximation (RMSEA) = .06, confidence interval (CI) [.05, .07]. Similarly, residual correlations indicated a reasonable local fit of the model to the data. See Table 1 for correlations between variables.

To test our hypothesis, we examined a serial mediation model to determine whether our experimental manipulation led to differences in perceived clarity, and subsequently, to differences in students’ ability to organize information from the lesson, and finally to differences in their test scores. We used PROCESS 3.0 to conduct ordinary least squares path analysis (Hayes, 2018). Importantly, because of the multicategorical nature of three randomly assigned conditions involving examples (as the indicator-coded independent variable with two dummy codes; X), differences in test scores due to the experimental manipulation through clarity and organization are relative serial indirect effects (see Hayes & Preacher, 2014). Relative serial indirect effects indicate that the indirect effects reported

**Table 1.** Correlation coefficients.

| Variable | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Clarity | | | | | |
| 2. Organization | .78** | | | | |
| 3. GPA | .04 | .09 | | | |
| 4. Familiarity | .38** | .33** | .00 | | |
| 5. Interest | .64** | .67** | .01 | .29** | |
| 6. Test % | .25** | .39** | .14* | .08 | .26** |

**$p < .01$. *$p < .05$.

here refer to (x1) mean differences between condition one (instructor-provided examples) and condition two (student-generated hypothetical examples), and (x2) mean differences between condition one (instructor-provided examples) and condition three (student-generated personal examples) as caused by the two sequential mediators (mediator 1: clarity, mediator 2: organization).

First, results from a serial mediation analysis indicated that, compared with instructor-provided examples, asking students to generate hypothetical examples indirectly influenced students' test scores through the impact this made on perceived clarity and subsequently through students' ability to organize the material they were learning. As shown in Table 2 (displaying unstandardized path coefficients), compared with instructor-provided examples, student-generated hypothetical examples led to perceptions of lower clarity (x1 → clarity: −.84, CI: −1.11, −.56) which was associated with students' ability to organize the material presented in the lesson (clear → org = .49, CI: .42, .57). The ability to organize the material from the lesson was positively related to students' test scores (org → test = 9.43, CI: 6.08, 12.78). The percentile bootstrapped confidence interval (5000 bootstrapped samples) for the relative serial indirect effect (x1 → clear → org → test: −3.91) of student-generated hypothetical examples compared with instructor-provided examples was entirely below zero (CI: −5.89, −2.27). There was no evidence that the experimental manipulation influenced test scores directly (x1 → test: 2.71, CI: −3.58, 9.00). Furthermore, the relative indirect effect of student-generated hypothetical examples did not differ from instructor-provided examples when examined solely by the indirect paths through clarity (x1 → clarity → test: 1.93, CI: −.65, 4.70) or organization (x1 → org → test: .98, CI: −.97, 2.87). These results indicate that, compared with students exposed to instructor-provided examples, students who generated their own hypothetical examples scored approximately 4% lower on their tests because the lesson was perceived to be unclear and, subsequently, because they had a difficult time organizing the material coherently.

Second, results from a serial mediation analysis conducted using ordinary least squares path analysis indicated that, compared with instructor-provided examples, asking students to generate personal examples indirectly influenced students' test scores through the impact this made on perceived clarity and subsequently through students' ability to organize the material they were learning. As shown in Table 2 (displaying unstandardized coefficients), compared with instructor-provided examples, student-generated personal examples led to perceptions of lower clarity (x2 → clarity: −.72, CI: −1.00, −.45), which was, in turn, associated with students' ability to organize the material presented in the lesson. The ability to organize the material from the lesson was positively related to students' test scores. The percentile bootstrapped confidence interval (5000 bootstrapped samples) for the relative serial indirect effect (x2 → clarity → org → test: −3.37) of student-generated personal examples compared with instructor-generated examples was entirely below zero (CI: −5.20, −1.85). There was no evidence that the experimental manipulation influenced test scores directly (x2 → test: 1.20, CI: −4.94, 7.34). Moreover, the relative indirect effect of student-generated personal examples on students' test scores did not differ from instructor-provided examples when examined solely through the paths of clarity (x2 → clarity → test: 1.67, CI: −.55, 4.16) or organization (x2 → org → test: −.56, CI: −2.37, 1.14). These results indicate that, compared with students exposed to instructor-provided examples, students who generated personal examples scored approximately

**Table 2.** OLS path model coefficients: serial mediation model.

| Models | Coefficient | SE | $t$ | $p$ | LLCI | ULCI |
|---|---|---|---|---|---|---|
| *Clarity* | | | | | | |
| $F(5, 322) = 66.52, p < .01, R^2 = .51$ | | | | | | |
| Constant | 1.95 | .46 | 4.22 | <.01 | 1.04 | 2.86 |
| x1 | −.84 | .14 | −5.87 | <.01 | −1.11 | −.56 |
| x2 | −.72 | .14 | −5.12 | <.01 | −1.00 | −.45 |
| GPA | .11 | .13 | .86 | .39 | −.14 | .36 |
| Familiarity | .22 | .04 | 5.94 | <.01 | .15 | .30 |
| Interest | .52 | .04 | 13.11 | <.01 | .44 | .60 |
| *Organization* | | | | | | |
| $F(6, 321) = 106.69, p < .01, R^2 = .67$ | | | | | | |
| Constant | .90 | .33 | 2.73 | <.01 | .25 | 1.55 |
| x1 | .10 | .10 | .99 | .32 | −.10 | .31 |
| x2 | −.06 | .10 | −.59 | .56 | −.26 | .14 |
| Clarity | .49 | .04 | 12.73 | <.01 | .42 | .57 |
| GPA | .18 | .09 | 2.01 | <.05 | <.01 | .35 |
| Familiarity | .02 | .03 | .74 | .46 | −.04 | .07 |
| Interest | .24 | .03 | 7.07 | <.01 | .18 | .31 |
| *Test score (%)* | | | | | | |
| $F(7, 320) = 10.28, p < .01, R^2 = .18$ | | | | | | |
| Constant | −1.35 | 10.21 | −.13 | .89 | −21.43 | 18.73 |
| x1 | 2.71 | 3.20 | .85 | .40 | −3.58 | 9.00 |
| x2 | 1.20 | 3.12 | .39 | .70 | −4.94 | 7.34 |
| Clarity | −2.31 | 1.45 | −1.59 | .11 | −5.17 | .55 |
| Organization | 9.43 | 1.70 | 5.54 | <.01 | 6.08 | 12.78 |
| GPA | 5.32 | 2.69 | 1.98 | <.05 | .03 | 10.62 |
| Familiarity | −.51 | .84 | −.61 | .54 | −2.16 | 1.14 |
| Interest | .83 | 1.13 | .74 | .46 | −1.39 | 3.05 |
| *Mediation* | | | | | Bootstrapped CI | |
| (*Condition* → *Clarity* → *Test*) | Boot SE | | | | LLCI | ULCI |
| Relative indirect effect for x1 | 1.93 | 1.38 | | | −.65 | 4.70 |
| Relative indirect effect for x2 | 1.67 | 1.21 | | | −.55 | 4.16 |
| *Mediation* | | | | | Bootstrapped CI | |
| (*Condition* → *Organization* → *Test*) | Boot SE | | | | LLCI | ULCI |
| Relative indirect effect for x1 | .98 | .96 | | | −.97 | 2.87 |
| Relative indirect effect for x2 | −.57 | .88 | | | −2.37 | 1.14 |
| *Serial Mediation* | | | | | Bootstrapped CI | |
| (*Condition* → *Clarity* → *Organization* → *Test* | Boot SE | | | | LLCI | ULCI |
| Relative serial indirect effect for x1 | −3.91 | .91 | | | −5.89 | −2.27 |
| Relative serial indirect effect for x2 | −3.37 | .85 | | | −5.20 | −1.85 |

Note. Path coefficients are unstandardized, and relative indirect effects represent student test scores out of 100%. For indicator-coded groups (x1 and x2), coefficients reflect mean differences in comparison with the referent group: instructor-generated examples. x1 = student-generated hypothetical examples; x2 = student-generated personal examples. Bootstrapped CIs that do not include zero reflect mediated effects. Boot = bootstrapped.

3% lower on their tests because the lesson was perceived to be unclear and, subsequently, because they had a difficult time organizing the material coherently. Overall, evidence for serial mediation was obtained.

## *Research Questions*

To test our first research question, the first author scored student examples on a 5-point scale while blind to students' scores on interest. Points were awarded in the following manner: (1) *no link to the instructional concept,* (2) *a slight link to the instructional concept*, (3) an *adequate link to the instructional concept*, (4) *a good link to the instructional concept*, and (5) *a very good link to the instructional concept* (student-generated hypothetical: $M$ = 2.71, $SD$ = 1.10; student-generated personal: $M$ = 3.07, $SD$ = 1.18). To examine our results, we conducted correlation analyses between student interest and the combined accuracy of students' five examples. Results indicated that interest was positively correlated with the accuracy of students' responses (student-generated hypothetical: $r_s = .26$, $p < .01$; student-generated personal: $r_s = .23$, $p < .05$).

Next, to test our second research question, we examined a conditional process model (Hayes, 2018; Hayes & Preacher, 2013) to determine whether our experimental manipulation led to differences in perceived clarity *dependent upon student interest*, and subsequently to students' ability to organize information from the lesson and ultimately their test scores. Results from a first-stage moderated serial mediation analysis using ordinary least squares path analysis indicated that there was a significant interaction between the experimental manipulation and student interest as it pertained to clarity (see Tables 3 and 4 for a complete list of results). Overall, the indices of moderated mediation (x1 = 1.97, CI: .65, 3.51; x2 = 2.17, CI: .88, 3.67; Hayes, 2015) indicated that, compared with students exposed to instructor-provided examples, students who generated their own examples scored less poorly on their tests because of the two sequential mediators as their interest became greater (low interest (−1 $SD$): x1 = −8.93, x2 = −8.68; average interest ($M$): x1 = −5.64, x2 = −5.06; and high interest (+1 $SD$): x1 = −2.35, x2: = −1.45). Results revealed that this was due to interest moderating the impact of student-generated examples on clarity. Students who generated their own examples and who reported high levels of interest (+1 $SD$) did not differ in their perceptions of clarity, whereas students who scored average ($M$) or low (−1 $SD$) did (x1: high interest → clarity = −.36, $p$ = .08; x2: high interest → clarity = −.22, $p$ = .26; x1:average interest → clarity = −.87, $p < .01$; x2: average interest → clarity = −.78, $p < .01$, x1:low interest → clarity = −1.37, $p < .01$; x2: low interest → clarity = −1.34, $p < .01$).

Results shown in Tables 3 and 4 illustrate that the difference between instructor-provided examples and student-generated examples led to differences in students' test scores through the moderated serial indirect path of clarity and subsequently through students' ability to organize the material in a coherent manner. In particular, results in Table 4 indicate that compared with students exposed to instructor-provided examples, students who generated their own examples and who were low in interest scored approximately nine percent lower on their tests through a reduction clarity and consequently their ability to organize the lesson. Compared with students exposed to instructor-provided examples, students who generated their own and who were average on the measure of interest scored approximately five to six percent lower on their tests because of this mediated process. Finally, compared with students exposed to instructor-provided examples, students who generated their own examples and who were high in interest scored approximately one to two percent lower on their tests because of the mediated process—though consistent with the overall trend, this last result was not significant for students who generated personal examples taken from their lives.

**Table 3.** OLS path model coefficients: moderated serial mediation.

| Models | Coefficient | SE | *t* | *p* | LLCI | ULCI |
|---|---|---|---|---|---|---|
| *Clarity* | | | | | | |
| $F(7, 320) = 52.01$, $p < .01$, $R^2 = .53$ | | | | | | |
| Constant | 2.98 | .52 | 5.75 | <.01 | 1.96 | 4.00 |
| x1 | −2.18 | .42 | −5.21 | <.01 | −3.00 | −1.36 |
| x2 | −2.23 | .44 | −5.11 | <.01 | −3.08 | −1.37 |
| Interest | .32 | .06 | 4.99 | <.01 | .19 | .44 |
| x1*Interest | .30 | .09 | 3.34 | <.01 | .12 | .48 |
| x2*Interest | .33 | .09 | 3.62 | <.01 | .15 | .52 |
| GPA | .08 | .12 | .69 | .49 | −.16 | .33 |
| Familiarity | .22 | .04 | 5.88 | <.01 | .14 | .29 |
| *Organization* | | | | | | |
| $F(5, 322) = 102.43$, $p < .01$, $R^2 = .61$ | | | | | | |
| Constant | 1.17 | .35 | 3.30 | <.01 | .47 | 1.86 |
| x1 | .17 | .11 | 1.49 | .14 | −.05 | .39 |
| x2 | .03 | .11 | .25 | .80 | −.18 | .24 |
| Clarity | .66 | .03 | 19.50 | <.01 | .59 | .72 |
| GPA | .16 | .09 | 1.72 | .09 | −.02 | .35 |
| Familiarity | .03 | .03 | .88 | .38 | −.03 | .08 |
| *Test score (%)* | | | | | | |
| $F(6, 321) = 11.92$, $p < .01$, $R^2 = .18$ | | | | | | |
| Constant | −.99 | 10.19 | −.10 | .92 | −21.03 | 19.05 |
| x1 | 2.85 | 3.19 | .89 | .37 | −3.43 | 9.12 |
| x2 | 1.49 | 3.09 | .48 | .63 | −4.60 | 7.57 |
| Clarity | −2.05 | 1.41 | −1.46 | .15 | −4.83 | .72 |
| Organization | 9.89 | 1.58 | 6.25 | <.01 | 6.78 | 13.00 |
| GPA | 5.20 | 2.68 | 1.94 | .05 | −.08 | 10.48 |
| Familiarity | −.50 | .84 | −.60 | .55 | −2.15 | 1.14 |
| *Mediation* | | | | | Bootstrapped CI | |
| (*Condition → Clarity → Test*) | | Boot SE | | | LLCI | ULCI |
| Index of moderated mediation for x1 | −.62 | .52 | | | −1.83 | .24 |
| Index of moderated mediation for x2 | −.69 | .56 | | | −1.93 | .27 |
| *Mediation* | | | | | Bootstrapped CI | |
| (*Condition → Organization → Test*) | | Boot SE | | | LLCI | ULCI |
| Relative indirect effect for x1 | 1.65 | 1.09 | | | −.49 | 3.81 |
| Relative indirect effect for x2 | .27 | 1.03 | | | −1.74 | 2.34 |
| *Serial Mediation* | | | | | Bootstrapped CI | |
| (*Condition → Clarity → Organization → Test*) | | Boot SE | | | LLCI | ULCI |
| Index of moderated mediation for x1 | 1.97 | .72 | | | .65 | 3.51 |
| Index of moderated mediation for x2 | 2.17 | .70 | | | .88 | 3.67 |

Note: Path coefficients are unstandardized, and relative indirect effects represent student test scores out of 100%. For indicator-coded groups (x1 and x2), coefficients reflect mean differences in comparison with the referent group: instructor-generated examples. x1 = student-generated hypothetical examples; x2 = student-generated personal examples. Bootstrapped CIs that do not include zero reflect mediated effects. Boot = bootstrapped.

## Discussion

Scholars have long known that examples are important for student learning. Dual coding theory would suggest this is because concrete examples provide students with imagery that allows them to encode their course lessons by way of two information-processing systems (Sadoski, Goetz, & Fritz, 1993). By presenting abstract concepts along with concrete examples, instructors can help students elaborate on their learning material to more easily form mental structures that aid in memory and comprehension (Sadoski & Paivo, 2013). Although knowing that the provision of examples is helpful for instructional

**Table 4.** Moderated serial indirect effects.

| Moderator: Interest | | | | |
|---|---|---|---|---|
| (*x1* → *Clarity* → *Organization* → *Test*) | θIE | Boot SE | Bootstrapped CI LLCI | Bootstrapped CI ULCI |
| 2.67 (low interest: −1 *SD*) | −8.93 | 2.09 | −13.43 | −5.17 |
| 4.33 (average interest: *M*) | −5.64 | 1.20 | −8.19 | −3.47 |
| 6.00 (high interest: +1 *SD*) | −2.36 | 1.19 | −4.75 | −.03 |
| (*x2* → *Clarity* → *Organization* → *Test*) | θIE | Boot SE | Bootstrapped CI LLCI | Bootstrapped CI ULCI |
| 2.67 (low interest: −1 *SD*) | −8.68 | 2.02 | −13.04 | −5.06 |
| 4.33 (average interest: *M*) | −5.06 | 1.19 | −7.60 | −2.96 |
| 6.00 (high interest: +1 *SD*) | −1.45 | 1.22 | −4.03 | .83 |

Note: θIE = unstandardized conditional serial indirect effects on test scores out of 100%. x1 and x2 reflect mean differences in comparison with instructor-generated examples. x1 = student-generated hypothetical examples; x2 = student-generated personal examples. Bootstrapped CIs that do not include zero reflect mediated effects. Boot = bootstrapped.

practitioners, we designed the current study to investigate differences between instructor-provided and student-generated examples as they pertain to student learning. In particular, our goal with this study was to determine whether providing examples of a brief lesson would enhance students' test scores compared with asking students to generate their own examples of this lesson. Across two manipulations of student-generated examples, our results showed that, compared with instructor-provided examples, students experienced lower perceptions of clarity with a course lesson and that this influenced their ability to organize their learning material which subsequently led to lower scores on a test of learning. This outcome was stronger as student interest in the material diminished. In other words, compared with students who scored higher on the measure of interest, students who reported lower interest and who generated their own examples were particularly likely to score lower on the test of learning because they perceived the lesson to be less clear and subsequently because they had a harder time organizing the lesson in a coherent manner.

The fact that instructor-provided examples particularly benefited students who did not score high on a measure of interest is noteworthy and might be explained by thinking about how students behave in class when they are interested (or not). Students who are not interested in their learning material tend to experience studying course lessons as more effortful (Hidi, 1990). As a result, uninterested students may be less willing than more interested students to invest resources into learning course concepts (Shiefele, 2016). To this point, research has shown that, compared with interested students, uninterested students are less likely to pay attention to course lessons and to be motivated to expend energy to learn (Bolkan & Griffin, 2018). Considering the above, we might expect uninterested students to generate poorer examples of the learning material compared with their more interested counterparts. In fact, results from our first research question support this conclusion.

If the examples from uninterested students are of lower quality compared with individuals who are more interested, we might expect that their explanations for classroom concepts would be less adequate compared with instructor-provided examples. This might be true for two reasons. First, from the standpoint of case-based reasoning, if instructor-provided examples are more accurate, they have more overlap with educational principles which makes their use as analogies more appropriate when solving similar problems or explaining similar cases. Second, scholars note that students are better able to learn course lessons when they explain the rationale behind an original problem (Chi et al., 1989; Reed et al., 1985). This is because when students are able to explain examples, they move beyond the surface-level features of these illustrations to focus on drawing conclusions and making inferences from the lessons provided in the examples (Chi et al., 1989). Essentially, students who elaborate on examples are able to use these illustrations to solve future problems the extent that they are able to identify how examples explain the principles they embody (Chi et al., 1989; Fiorella & Mayer, 2016). If this is the case, instructor-provided examples (that are likely to be more thorough and accurate than those generated by students) may be particularly important for helping uninterested students link concrete illustrations to important instructional principles.

Results from this study also inform our understanding of the impact of clarity on learning. Specifically, results from this study show that the impact of clarity on learning was not direct, but occurred through students' ability to organize the lesson in a coherent manner. Recall that CTML scholars define organization as the creation of mental models or knowledge structures that facilitate students' sense making (Mayer, 2009, 2014). Thus, results from this study demonstrate that clear lessons are not just helpful to students because they are simple or straightforward. Instead, the influence of clear lessons on student learning likely stems from their ability to help students engage in essential information-processing activities (Bolkan, 2016, 2019; Mayer, 2009). The explanation for this result stems from cognitive load theory (Plass et al., 2010; Sweller et al., 2011) which states that students have limited working memory capacities and that instructional design should be respectful of these limitations (Sweller, van Merrienboer, & Plass, 1998) because students who are cognitively overloaded may not have the capacity in working memory to discern meaning from, and make sense out of, their lessons (Sweller et al., 1998). We found support for this conclusion in our study. Compared with students who found the lesson to be unclear, students who perceived the lesson to be clear were more successful at organizing the lesson coherently.

As can be seen in the final step of our model, students who were better able to organize the lesson scored higher on their tests of learning. This finding is in line with CTML that claims student learning is a function of active information processing (Mayer, 2009, 2014) which occurs to the extent that students transform information into usable knowledge in the form of mental schemas (Fiorella & Mayer, 2016). In line with these arguments, Chi et al. (1989) noted that students might be able to understand and use examples to solve future problems to the extent that they are able to create mental models that explain the principles that examples embody. Similar to our results, Chi et al. (1989) found that students who scored better on tests of learning were those individuals who elaborated on examples by generating explanatory ideas about how these related to the major ideas being referenced.

### *Implications for teaching and learning*

Generally, data from this study suggest that when explaining course lessons, teachers may be in the best position to provide examples of the concepts being taught. Although students might generate accurate and thorough examples on their own, this outcome is not guaranteed, particularly when students lack interest in the material. To address this issue, instructors can provide concrete examples of important concepts to help make their lessons clear, which should help students form appropriate and useful mental models of the ideas they are learning.

It seems reasonable that results from this study may lead readers to conclude that communicating concrete examples to students is superior to asking them to create examples themselves. However, an alternative method of instruction might include combining teacher and student efforts to better facilitate understanding. Clarity is multidimensional, and part of being a clear instructor involves working with students to ensure they interpret course information the way instructors intended (Bolkan, 2017a). This component of clarity is known as interaction and has been advocated by several scholars who study clear communication (Civikly, 1992; Simonds, 1997). Thus, perhaps one way to help students learn course material would be to ask them for examples to help them engage in constructive learning processes (Chi, 2009, Chi & Wiley, 2014). However, instead of leaving students to their own devices, it would be important for teachers to review students' examples and correct these when these are shown to be poor representations of instructional phenomena. Another alternative to simply providing examples of the learning material might be to help students engage in structuring general schemas from the examples they provide. By asking students to self-explain why their examples associate with the learning material, instructors might help students engage in generative processing to help them move beyond the surface structure of their examples to focus on the underlying lessons these are intended to illustrate (Fiorella & Mayer, 2016). Finally, instructors might consider combining their own examples with student examples to help their pupils learn. For instance, instructors can provide examples and then ask student to generate their own to help provide accurate illustrations of course material with the added benefit of helping students link course ideas to their personal base of knowledge.

## *Limitations and future directions*

Results from this study should be interpreted in light of several limitations. One limitation includes the artificial nature of the learning activity studied in this experiment. Because students read a brief lesson, outside of class, for extra credit, we cannot be sure if findings from this project generalize to natural learning environments. For example, students listening to a lesson in class might be more motivated to think critically about the material and might therefore be more likely to develop stronger examples than the ones found in this study. If this is the case, differences between instructor-provided and student-generated examples may not differ as much as they did in the current investigation. In the future, researchers should consider examining the effects of student-generated examples in natural learning environments to determine if the results found in this study can be replicated in various learning contexts.

Another limitation of this study pertains to the number of examples students were asked to create for this investigation. In the current project, we asked students to generate five examples representing the concepts being taught in the lesson. It could be the case that asking students to come up with so many examples overwhelmed their ability to focus on the meaning of the lesson. In the future, researchers might consider studying how asking for fewer examples might change the results reported in this manuscript. Additionally, researchers may consider examining how various sources of examples influence student learning when compared with providing none. This way, researchers could document whether student-generated examples result in the same level of learning compared with no examples, or whether student-generated examples are detrimental to learning when compared with no examples.

Finally, this study only investigated one moderator that changed the nature of the relationship between student-generated examples and perceived clarity. It could be that other moderators matter as well and further reduce the differences between instructor-provided and student-generated examples and clarity (Goodboy, 2017). For example, students who are more attentive to a course lesson might rely less on examples to inform their comprehension. Similarly, students who are self-controlled or mastery-oriented might better focus on creating connections between their examples and a course lesson. If these proposed ideas have merit, researchers might find that the difference between instructor-provided and student-generated examples disappears altogether.

## Conclusion

In summary, results from this experiment point to the conclusion that the source of examples in classroom lessons matters insofar as it can help increase perceptions of lesson clarity. To this point, providing examples to students seems to benefit student comprehension compared with asking students to generate their own—especially for pupils who are not interested in the learning material. We speculate that this result might stem from the quality of students' examples compared with those provided by the instructor. Of course, it is important to get students involved in the learning process. Thus, because there are benefits to asking students to come up with examples themselves, working with students to develop examples and then helping them to correct, adjust, or reframe these to align with course principles is essential. Finally, our results point to an important mechanism that explains how clear instruction enhances student learning. Specifically, we were able to show that clear teaching benefits students by helping them classify, generalize, and organize their lessons in a coherent manner. Ultimately, results from this study suggest that a simple pedagogical choice of how to incorporate examples into a lesson can make a difference in students' test scores because of how these are processed during learning episodes.

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## Appendix: Examples

### *Instructor-provided*

1. *Severity*: “Even if people think they might get a disease, if the illness is not considered to be too threatening (i.e., a common cold), they might not experience a sense of threat (due to a lack of severity).”
2. *Susceptibility*: “Although a fear appeal about a disease or sickness might be severe, if people do not think that they can get the disease where they live there won’t be a sense of threat (due to a lack of susceptibility).”
3. *Self-efficacy*: “If a person recommends that to avoid getting a disease I should avoid all human contact for 3 weeks, I might not follow these recommendations because I probably cannot engage in that behavior (due to a lack of self-efficacy).”
4. *Response efficacy*: “If the behavior recommended to avoid the disease simply included singing in the shower, I might do that because I know that singing does little to protect me from getting an illness (due to a lack of response efficacy).”
5. *Cost*: “If the behavior recommended to avoid a disease was to get a shot/vaccination from a doctor who only has an office across the country, I might not go and get it (because the costs involved in getting the shot are too high).”

### *Student-generated hypothetical*

1. Severity
   *Weak*: “Putting gas in their car.” “A meeting with an authority figure.”
   *Strong*: “If you don’t lose weight, you’re going to die.” “Showing people pictures what could happen to your lungs when you smoke too much.”
2. Susceptibility
   *Weak*: “Petting a dog and it bites you.” “Moving to a new state.”
   *Strong*: “Suspecting there’s a shark in the ocean where you are swimming.” “If you’ve been attacked or something alone outside before, you might be weary to walk alone at night.”

3. Self-efficacy
   *Weak*: "Flirting with a cop to get out of a ticket." "Running a marathon."
   *Strong*: "Someone who knows karate not being afraid of walk down an ally in the middle of the night because they believe they can fight off anyone." "A student doesn't study to pass a test because the material is too hard."
4. Response efficacy
   *Weak*: "If you have too much confidence and get cocky." "The person planning the surprise birthday party gets 20 people to RSVP."
   *Strong*: "See others results of working out and losing weight so they decide to do it themselves because it will work." "A person might buy a cleaning product because they've seen how well it works in demonstrations."
5. Cost
   *Weak*: "If you dare someone to act like a clown for money." "Speeding to get to school on time for a class."
   *Strong*: "An example of this would be if someone doesn't want to recycle because it takes too long to drop off their recycling." "Driving downtown in a city is a hassle so people are less likely to do so."

### *Student-generated personal*

1. Severity
   *Weak*: "When I don't finish my tasks." "The first time I was in a situation like this was when I was in my first car wreck in the snow."
   *Strong*: "In high school, plagiarism made me feel a sense of threat because of the severity of the punishment." "I have a fear of losing my scholarship at the school due to failing some classes and the government has sent me emails warning me about it."
2. Susceptibility
   *Weak*: "Talking to cops." "I felt threatened when I drink."
   *Strong*: "I got the flu shot this year because I knew that anyone could contract the flu, including myself." "There was a time where my dad threatened to kick me out of the house after a big fight we had, but I knew he wouldn't go through with it."
3. Self-efficacy
   *Weak*: "In an online class with lack of teaching." "A behavior I perform is not drinking soda because I have been told it is bad for you and you lose weight if you don't drink any."
   *Strong*: "I didn't believe that I could get my driver's license, so I didn't even try." "As a sophomore in high school, I enrolled in the Honors English class, believing that I could handle whatever the instructor was ready to test us on because I had been told by peers that I was good at writing."
4. Response efficacy
   *Weak*: "One time my mom wanted me to come home at 11 pm but I wanted to be with my friends until the very last moment so I sped home in my car and ended up getting pulled over." "When I am driving and people cut me off, I go around them fast so they do not hit me."
   *Strong*: "Meal prepping will lead to weight loss." "For a different class, I believed that if I studied, a recommended behavior, then I would get the desired result, a good grade on the test."
5. Cost
   *Weak*: "Buying a better bed." "When I decided to stand up to the bully."
   *Strong*: "Not talking to teachers because I felt like it would affect me later." "I started going to yoga lessons and loved it. This was a new part of exercising for me but the cost per class was a bit much and became a barrier."

*Note.* Weak examples were scored as a 1 (no link to the instructional concept), strong examples were scored as a 5 (a very good link to the instructional concept).