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Isolation and distinctiveness in the design of e-learning systems influence user preferences

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ABSTRACT

When faced with excessive detail in an online environment, typical users have difficulty processing all the elements of representation. This in turn creates cognitive overload, which narrows the user's focus to a few select items. In the context of e-learning, we translated this aspect as the learner's demand for a system that facilitates the retrieval of learning content – one in which the representation is easy to read and understand. We hypothesized that the representation of content in an e-learning system's design is an important antecedent for learner preferences. The aspects of isolation and distinctiveness were incorporated into the design of e-learning representation as an attempt to promote student cognition. Following its development, the model was empirically validated by conducting a survey of 300 university students. We found that isolation and distinctiveness in the design elements appeared to facilitate the ability of students to read and remember online learning content. This in turn was found to drive user preferences for using e-learning systems. The findings provide designers with managerial insights for enticing learners to continue using e-learning systems.

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Human–computer interface; interactive learning environments; post-secondary education; pedagogical issues

1. Introduction

Current research on e-learning systems has focused too much on the "explore, find, and retrieve" paradigm while neglecting the specific aspects of e-learning design (Cassarino, 2003; Santos, Boticario, & Pérez-Marín, 2014; Vesper, Herrington, Kartoğlu, & Reeves, 2015). Although e-learning systems are not always designed with attention to metacognitive processes, cognition and metacognition are part of the overall continuum of learning and are strongly related to improved recognition in e-learning environments (Shih, Feng, & Tsai, 2008). Schmidt (1991) describes recognition as a selective-attention mechanism that results from salience in the presentation of the item. He adds that differential attention is not sufficient for enhanced memory because the retrieval context of reading must be taken into account. As such, distinctiveness is considered an elaborative encoding process that facilitates the retrieval, or remembering, of content (Hunt, 2006). Schmidt describes distinctiveness effects, including isolation effects, as those that are "inconsistent with active conceptual frameworks, or that contain salient features not present in active memory. These events lead to increased attention in direct proportion to the degree of incongruity" (p. 537). Von Restorff's isolation effect is considered the basis for this view of distinctiveness.

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Designers of e-learning systems tend to neglect readability and memorability (Fernandez, Insfran, & Abrahão, 2009; Richardson, Drexler, & Delparte, 2014). As noted by Schmidt, however, readability in online environments is essential for increasing attention to the content. Referring to the von Restorff effect, Hill and Scharff (1997) found that the readability of content affects how well it is remembered (memorability). The consistency between design elements can provide additional transference of learned skills from a current object to a new one. This is because consistency helps the user predict system responses and interact with the content (Brehmer, 1978; Rhee, Moon, & Choe, 2006).

Consistency can help reduce demands on cognitive load and increase efficiency (Altaboli & Abou-Zeid, 2007). Some researchers have linked facilitating cognitive load to arranging content segments according to one or more rules (Moreira & Santos, 1981; Neris, Anacleto, Mascarenhas, & Neto, 2005), while others emphasize the sequence of elements and how they are displayed on the screen (Al-Samarraie, Teo, & Abbas, 2013). Few studies, however, have examined the role of consistency in the arrangement of segments and the sequence of elements in e-learning design representation. As such, we argue that it remains unclear what makes for consistency in e-learning representation design. This deficiency led us to ask the following research question: How can the organizational and structural aspects of e-learning representation, grouped according to their consistency, facilitate cognitive processes in reading and remembering content?

1.1. The von Restorff effect

The von Restorff effect is observed when an object is embedded within a representation in different structures or forms. Von Restorff argued that when an individual identifies the main element in a subject, he or she is better able to remember the content. This phenomenon is attributed to the isolation and distinctiveness of the main element relative to other elements (e.g. a long word in a list of short words). As cited in Hunt (1995), Von Restorff (1933) defined distinctiveness as “a descriptive term for events that violate the prevailing context – that is, for events that are perceptually salient” (p. 106). Thus, distinctiveness acts as an independent variable that affects memory, where the isolation effect is an instance of distinctiveness having an effect on memory. The difference between the effects of isolation in particular and distinctiveness in general is that the perceptual salience of the distinctive experience in isolation results from reading, which in turn stimulates additional processing. The distinctiveness of content representation usually occurs during the refinement of processing levels.

The recall process depends on the relationship between reading and remembering: readers must acquire a good understanding to readily remember. For von Restorff, the isolation process helps enhance the recall of an “isolated” item in relation to non-isolated items (Hunt, 1995). Supporting this idea, recent research has reported that using contrast in presenting content enhances readability and memorability. For example, Markman and Gentner (1993) argued that differences in representation come to mind more quickly than standard representations. This was supported by Shieh and Lin (2000), who found that target/background colour combination had a significant effect on visual-identification performance and subjective preferences.

Fabiani and Donchin (1995) showed that introducing new elements into reading materials can result in isolation for free recall. They found that in the process of recalling items, isolated items were reported separately from other items, and the information-encoding process that occurred while reading predicted the recall of isolated items. This accords with our assumption that the recognition of content for recall depends mostly on the isolation and distinctiveness of items.

1.2. Hypotheses

The organization of representation in a system is the manner in which elements of the representation are arranged based on one or more rules related to the interaction between content organization, webpage and navigation design (Djonov, 2007). Djonov (2007) argues that the quality of an online system depends on the user's ability to conceptualize the organization of information. This is based on the assumption that a user explores new elements while navigating from one web page to another, influenced by the interactions between content organization, web page design and navigation design.

The relationship between the characteristics of an e-learning system's representation and the user's learning activity has not been investigated. Researchers like Katona (1967), Bol et al. (2014) and Lee and Shin (2015) argued that the organization of information can facilitate the user's ability to remember it. We propose that readability and memorability are affected by the organization of a system's representation; thus, Hypotheses 1 and 2:

Hypothesis 1: The organization of a representation will affect learner perceptions of readability.
Hypothesis 2: The organization of a representation will affect learner perceptions of memorability.

Another design aspect is consistency, which is a way to make a system's features recognizable and easily differentiated within the representation (Bellur & Vallieswaran, 2006). As Zaharias (2009) notes, "It is critical that systems designers assess the range of possible affective states that users may experience while interacting with the system" (p. 1). Affective states are influenced by consistency in representation (Muhtaseb, Lakiotaki, & Matsatsinis, 2012), and maintaining consistency throughout a system aids in its navigation and use (Attardi & Simi, 1981; Hu & Kuang, 2014; Ritter, Baxter, & Churchill, 2014). We propose that the design of e-learning is comprised of consistency rules based on relations between the different representation schemes that acts as entities.

Grudin (1992) argues that interface consistency is a fuzzy concept. In addition, very few studies have empirically investigated interface consistency and its relationship to cognitive states for processing information. Finstad (2008) reported that consistent interfaces can cause users to overgeneralize functions within the interface. He attributes this overgeneralization to user confusion in which they are forced to redevelop mental models. As such, interface consistency can be considered detrimental to performance. Thus, we suggest that the vague role of consistency in the representation design of e-learning systems affects perceptions of readability and recall ability. We assume that if a learner can navigate and successfully use a particular e-learning system with all of its specific elements and attributes, perceived readability and memorability will increase; thus, we propose Hypotheses 3 and 4:

Hypothesis 3: The consistency of a representation will affect learner perceptions of readability.
Hypothesis 4: The consistency of a representation will affect learner perceptions of memorability.

As with consistency in representation, structure directs attention to use and the effectiveness of use (Al-Samarraie et al., 2013). If a learner perceives the e-learning environment to be easy and effective, he or she is more likely to benefit from it (Al-Samarraie, Selim, & Zaqout, in press; Romiszowski & Chang, 1992). Eastmond (1995) and Romiszowski and Chang (1992) found that the design of a system's representation might affect student learning and retention. Retention reflects the ability of the user to remember or memorize information stimulated by effective reading (Katona, 1967; Noice & Noice, 2006).

In addition, the complexity of the learning elements and a lack of structure on the page might reduce memorability (Botta, 2010). Remembering content, therefore, can be associated with well-structured representation. This leads us to propose that the structure of a system's representation can affect memorability and perceptions of readability. It is also assumed that the structure of representation design can provide a type of isolation that facilitates distinctiveness in the learning content. Thus, we propose Hypotheses 5 and 6:

Hypothesis 5: The structure of a representation will affect learner perceptions of readability.
Hypothesis 6: The structure of a representation will affect learner perceptions of memorability.

Individual preferences is a function that form a set of independent necessary for making decisions to use or adapt certain aspect. Ozdamar-Keskin, Ozata, Banar, and Royle (2015) argued that learners can be driven by the learning attributes in a certain conditions to which it regulate their learning preferences to use online means for learning. Such preferences can be inferred by cognitive characteristics based on learners' overall perception of the learning environment which may consists on their ability to process and recall a given content. On the other hand, Liu, He, Wang, Song, and Du (2013) stated that preferences of users to use a system can be inferred based on the features that meets their needs. In this study, we assumed that providing such features in e-learning can be achieved by isolating content along with the distinctiveness of its feature.

This is because learner's learning preferences (such as working memory capacity, richness of presentation, etc.) can be frequently updated based on the interactions of the learner with the display (Jeong & Hong, 2013; Kim, Byun, & Jeong, 2013).

Based on these observations, a limitation of the research on preference construction in a learning context is lacking of narrow focus on the choice context of design aspects for facilitating information processing among learners. Hence, preferences in this study refer to students decision to use the proposed e-learning system by promoting their readability and memorability of learning contents.

Maycock and Keating (2014) addressed the elements of learning environment in terms of working memory, readability, information processing speed and the pedagogic preference. Where the readability level of instructional content was used as a minor indicator for the suitability of instructional content for a given learner.

On the other hand, Rashid et al. (2002) suggest that user expectations are better predictors of other preferences than other attributes. Thus, the preference to use or adapt is commonly correlated with the benefits one expects to gain from experiencing the process. In e-learning, the problem with providing so much detail online is that a typical learner cannot cope with all the elements of representation. This in turn creates cognitive overload, which narrows the focus to a few select items. Such aspect can be understood as the learner's demand for a system that facilitates the retrieval of learning content – one in which representation is easy to read and understand. This can be achieved by incorporating the main design schemes that contribute to the learner's cognitive ability for processing and recalling information (Lee & Tedder, 2003). Hartmann, Sutcliffe, and Angeli (2008) define processing and recalling information as the ease with which a user can remember and make decisions about content; Adikari, McDonald, and Collings (2006) consider this a condition for carrying out tasks. These observations suggest that an empowered cognitive state can guide behaviour towards achieving learning goals. Thus, we propose that the learner's ability to read and remember – stimulated by the way information is structured and the consistency in using distinctiveness within the isolation elements of the design representation – is the main predictor of his or her preference for using an e-learning system. Thus, Hypotheses 7 and 8 are proposed:

Hypothesis 7: Learners' perceptions of the readability of a system's representation influence their preference for using the system.

Hypothesis 8: Learners' perceptions of the memorability of a system's representation influence their preference for using the system.

The full research model is shown in Figure 1.

2. Method and materials

2.1. Distinctiveness and isolation in the design of e-learning representation

Website design researchers have found that interface characteristics and cognitive capacity, cross-platform design, and linking are important factors that affect the quality of system interfaces (Chong, Lim, & Ling, 2009; Hall & Hanna, 2004). Von Restorff explained that success in each of these factors can influence user perceptions of the content. Figure 2 shows how we incorporated von Restorff's principles into the design of e-learning representation. Although isolating content is essential, other design attributes associated with isolation can play key roles in improving cognitive ability. Therefore, we integrated distinctiveness into isolation to facilitate the readability and memorability of content.

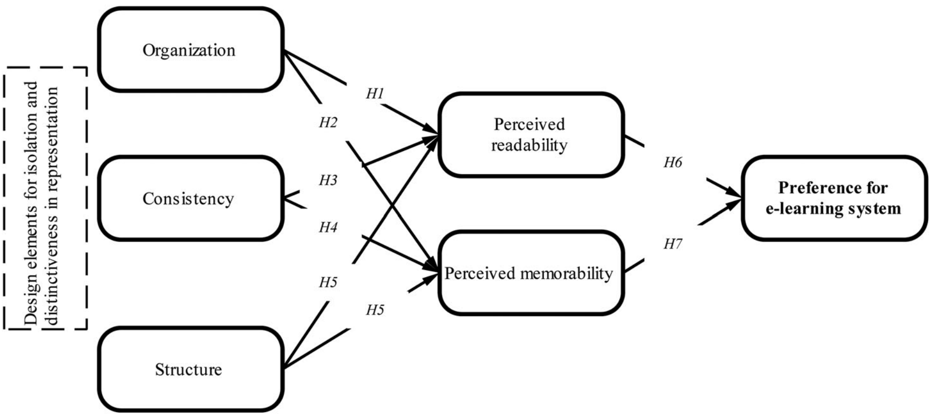

Figure 1. Research model.

We isolated the content into segments covering subaspects of the courseware; these segments create what we refer to as *structures*. The structure of the content was customized based on Botta's recommendations for well-structured representation – specifically, a precise, distinct, determinate and unambiguous structure. In our design, no design element overlaps with any other design element, there is a measurable amount of distance between design elements that does not change with context.

In addition, the key principle for organizing information in design is classification (Djonov, 2007). Hence, the isolations of the learning courseware were organized into a matrix to simplify the user's recognition of the segments represented on the page.

Enriching the structure and organization of the courseware elements in e-learning representation demands a reasonable consistency. Few studies have mentioned the importance of consistency in having a favourable experience when viewing an object. However, the best utilization of consistency

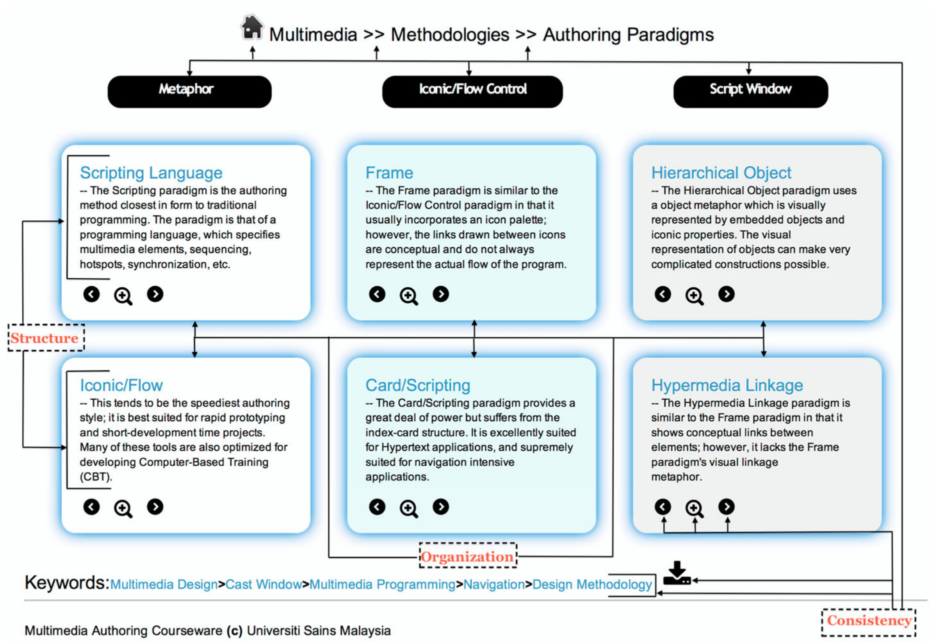

Figure 2. The proposed representation.

in e-learning systems is unclear and inadequately covered by previous studies. We believe that an unclear understanding of applying consistency in e-learning system design contributes to the current problems with students' interest in using these systems. Conceptual consistency has been defined as the consistency of the metaphor used in the design of a system (Altaboli & Abou-Zeid, 2007; Cheung & Lee, 2005; Rhee et al., 2006; Zviran, Glezer, & Avni, 2006).

Such a concept can be found in the objects that facilitate navigation across the representation. Hence, to ensure distinctiveness between these isolated/organized segments, we provided consistent divisions between the segments to make it easy for the user to distinguish between items as recommended, which also includes the navigational experience. We refer to this as the consistency of the structure (segments) organized in a matrix form.

2.2. Participants

The research subjects were undergraduate students enrolled in four programmes at a university in Malaysia. Data were collected over the course of the first semester of the academic year 2013–2014. Table 1 lists the respondents profile who answered the questionnaires based on their gender, age and programme type. Of the 300 participants, 225 (75%) responded. Eighteen of the returned surveys (8%) were unusable; thus, 207 (92%) usable surveys were obtained for analysis. A total of 122 (59%) participants were female, and 85 were male (41%). While the ages of participant were 44 (21.3%) between 18 and 20, 106 (51.2) between 21 and 23, and 57 (27.5) above 24. The majority came from science-related fields (115, 55.5%), while the rest came from applied-arts fields (92, 44.5%).

2.3. Procedure

The participants were invited to browse content related to their area of study in the developed e-learning system. Seven instructors from four schools encouraged their students to use the system. They ensured student participation by introducing books related to their programme at the end of every lesson using the e-learning system for approximately 10 min. The instructors were selected based on their teaching fields to cover all programmes selected for the study. Each student group consisted of 40–50 students.

After using the system for 2 months, the students were invited to complete a survey via e-mail. Of the 300 participants, 225 (75%) responded. Data were collected over the course of the first semester of the 2013–2014 academic year. Eighteen of the returned surveys (8%) were unusable; thus, 207 (92%) usable surveys were obtained for analysis.

2.4. Instrument

The survey assessed six key areas: organization of representation, structure of representation, consistency of representation, perceived readability, perceived memorability and preference for using the system. Each domain had three questions, resulting in a total of 18 questions on the survey. The

Table 1. Profile of the participant.

Description	Category	Frequencies	Percentage
Gender	Male	122	59
	Female	85	41
Age	18–20	44	21.3
	21–23	106	51.2
	<24	57	27.5
Programme	Pure sciences	42	20.2
	Applied sciences	73	35.3
	Pure art	43	20.8
	Applied art	49	23.7

survey was validated and tested for reliability. A total of three items were modified in accordance with Chin, Diehl, and Norman (1988) for measuring organization of representation; Pituch and Lee (2006) and Selim (2007) for structure of representation; and Bourgonjon, Valcke, Soetaert, and Schellens (2010) for preference to use. Items related to readability and memorability were self-developed based on the von Restorff effect. All items were measured based on the 5-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree.

A pilot test was conducted with 55 participants to check the validity of the instrument. The pilot questionnaire had 20 items. After analysing the primary results, two items were removed because of low reliability thresholds with Cronbach's alpha, $\alpha < 0.7$. A total of 18 items were found to be valid for the survey.

2.5. Data analysis

Structural equation modelling (SEM) was used to test the relationships among the factors forming the research model based on the 207 responses. SEM is a powerful method for testing causal models involving a set of independent and dependent factors (Byrne, 2010).

3. Results and discussion

3.1. Descriptive statistics

The descriptive statistics of the constructs are shown in Table 2. All means were above the midpoint of 3.00. The standard deviations indicated a slight spread around the mean, and skewness and kurtosis indicated adequate degrees of normality for the purposes of SEM (Kline, 2005).

3.2. Evaluation of the measurement model

Confirmatory factor analysis (CFA) was conducted to assess the overall measurement model. The mean values of skewness and kurtosis were smaller than the prescribed levels (skewness: 2.0, kurtosis: 7.0), indicating no significant problems regarding the multivariate normality of the data (Muthén, Kaplan, & Hollis, 1987). In addition, for the measurement model to have a sufficiently good model fit, the ratio of the χ^2 value to degrees of freedom (χ^2/df) should not exceed 3, and the comparative fit index (CFI), Tucker–Lewis index (TLI) and non-normed fit index (NNFI) should exceed 0.9. Furthermore, the root mean square error of approximation (RMSEA) should not exceed 0.05 (Hu & Bentler, 1998). The results of CFA were as follows: $\chi^2 = 194.036$, $\chi^2/\text{df} = 1.136$, TLI = 0.950, CFI = 0.961, NNFI = 0.904 and RMSEA = 0.049. These results confirm that the hypothesized model fit the data and was suitable for structural modelling.

3.3. Results of the measurement model

As shown in Table 3, the Cronbach's α coefficient ranged from 0.803 to 0.857. Thus, the results presented in Tables 3 and 4 support the high internal consistency of the instrument with all values above

Table 2. Descriptive statistics of the constructs.

Construct	Item	Mean	SD	Skewness	Kurtosis
Organization of representation	3	3.80	0.857	−0.914	0.108
Structure of representation	3	3.74	0.749	−0.965	1.406
Consistency of presentation	3	3.76	0.808	−0.852	0.629
Perceived readability	3	3.49	0.771	−0.637	0.350
Perceived memorability	3	3.89	0.649	−1.093	2.472
Preference to use	3	3.93	0.758	−0.787	0.668

Table 3. Efficacy of system representation for student preference to use e-learning system.

Constructs	Factor loading (>0.70)	CR (>0.70)	AVE (>0.50)	Cronbach's α (>0.70)	Reference
Organization of representation		0.842	0.641	0.840	Modified from Chin et al. (1988)
1. The representation of content was organized in such a manner that I found it relevant to my thoughts.	0.802				
2. I was able to locate the learning sections of the courseware using this system.	0.810				
3. I am satisfied with the way content is organized in this system.	0.789				
Structure of representation		0.812	0.593	0.813	Modified from Pituch and Lee (2006); Selim (2007)
4. I can clearly display the learning content using this system.	0.754				
5. I understand the structure of the e-learning components using this system.	0.769				
6. It was easy to navigate the learning content in this system.	0.786				
Consistency of presentation		0.824	0.610	0.825	
7. Consistent commands were employed throughout the system.	0.771				Modified from Power (2002)
8. The sequence of the sections enabled me to control my learning activities in the system.	0.781				
9. The overall sequence of screens in the system was clear to me.	0.790				
Perceived readability		0.802	0.577	0.803	
10. I was able to devote more time to reading my learning courseware in this system.	0.742				Self-developed
11. The placement of the content was eye-catching and easy to read.	0.760				
12. I was able to differentiate between the different sections of the learning courseware presented in this system.	0.776				
Perceived memorability		0.812	0.589	0.810	
13. I was able to remember information related to my learning using this system.	0.783				Self-developed
14. When I used this system for the first time, I perceived a difference in my ability to remember the courseware's content.	0.770				
15. I am able to link some learning activities with the information I read in this system.	0.750				
Preference for this e-learning system		0.856	0.667	0.857	
16. If I had a choice, I would choose this system for content representation.	0.831				Modified from Bourgonjon et al. (2010)
17. Given the option, I would vote in favour of using this system during my learning journey.	0.819				
18. I am excited about using this system in the classroom.	0.800				

the suggested level of 0.70 for scale robustness. The factor loadings for all items exceeded the recommended level of 0.70. The factor loadings are the correlation coefficients between the items/questions and factors. The square of the factor loading indicates the proportion of variance shared by the item with the factor. The composite reliability (CR) values of the constructs (0.802–0.856) exceeded the generally accepted value of 0.70. In addition, the average variance extracted (AVE) for all six constructs was greater than the benchmark of 0.50 recommended by Fornell and Larcker (1981). The computed AVE values ranged from 0.577 to 0.667. AVE can be used to evaluate discriminant validity. The findings of this study showed positive correlations for all hypotheses. The results of the survey are presented in Table 3. Table 4 presents the correlation matrix for the six constructs and the square root of the AVE. The discriminant validity assessment did not reveal any problems.

Table 4. Correlations in system representation.

		Correlation					
		1	*2*	*3*	*4*	*5*	*6*
1	Organization of representation	**0.800**					
2	Consistency of representation	.528**	**0.770**				
3	Structure of representation	.371**	.372**	**0.781**			
4	Perceived readability	.372**	.352**	.381**	**0.759**		
5	Perceived memorability	.463**	.475**	.493**	.322**	**0.767**	
6	Preference for this e-learning system	.417**	.421**	.569**	.480**	.622**	**0.816**

**Correlation is significant at the .01 level (two tailed).

3.4. Reliability and convergent validity

The convergent validity of the items was tested using the three criteria suggested by Fornell and Larcker (1981): all indicator loadings should be significant and larger than 0.7, CR should be above 0.7 and the AVE for each construct should be above 0.5. Cronbach's α remains a commonly applied internal consistency reliability estimate. It provides a measure showing that each construct was measured correctly and reliably. Cronbach's α provides a score between 0 and 1, with 0.7 generally accepted as a sign of reliability (Cronbach, 1951; Fornell & Larcker, 1981). Cronbach's α values were calculated for each construct.

AVE was used to indicate the average percentage of variance in the items accounted for by the construct. The square root of the AVE for each construct should be greater than the correlations between that construct and all other constructs (Fornell & Larcker, 1981). The average variance shared between the constructs and their measures should be greater than the variances shared between the constructs themselves.

3.5. Assessment of the structural model

The first step in model estimation involved examining the goodness of fit of the hypothesized model shown in Figure 3. The structural model yielded a χ^2 value of 184.296 with 124 degrees of freedom (χ^2/df = 1.486). All fit indices of the structural model were satisfactory (CFI = 0.967, TLI = 0.959, NNFI = 0.906, RMSEA = 0.049). The results of the analysis of the final structural model – including path coefficients, path significance and the variance explained (R^2) value for each dependent variable – are presented in Figure 3 and Table 5.

The second step in model estimation involved examining the significance of each hypothesized path in the research model. The results showed that the organization of the system representation

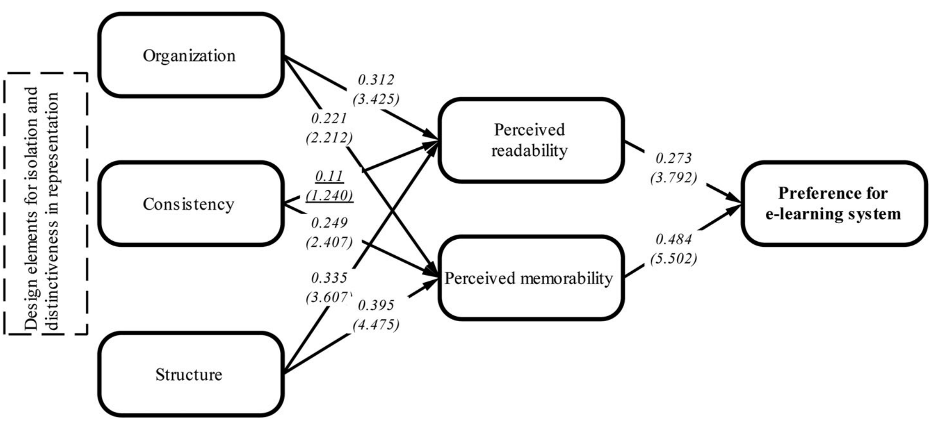

Figure 3. The tested model.

Table 5. Results of the final structural model.

Endogenous variables	Determinant	Path (*t*-value)	Support
Perceived readability ($R^2 = 0.55$)	Organization	0.312 (3.425)	Supported
	Consistency	0.11 (1.240)	Not supported
	Structure	0.335 (3.607)	Supported
Perceived memorability ($R^2 = 0.65$)	Organization	0.221 (2.212)	Supported
	Consistency	0.249 (2.407)	Supported
	Structure	0.395 (4.475)	Supported
Preference for e-learning system ($R^2 = 0.53$)	Perceived readability	0.273 (3.792)	Supported
	Perceived memorability	0.484 (5.502)	Supported

of e-learning content positively and significantly affected learner perceptions of readability. This confirms the first hypothesis, with a standard coefficient of 0.312 and a *t*-value of 3.425. The second hypothesis was also supported, indicating that the organization of the system representation of e-learning content positively (standard coefficient = 0.221) and significantly (*t*-value = 2.212) affected learner perceptions of memorability.

The results, as presented in Table 5 and Figure 3, showed that consistency of representation did not significantly affect perceived readability; the standard coefficient was 0.11, and the *t*-value was 1.240, which is less than 1.96, the threshold value for significance. Thus, the third hypothesis was not supported. Hypothesis 4, however, was supported. Consistency of representation positively and significantly influenced learner perceptions of memorability. The standard coefficient was 0.249 with a *t*-value of 2.407. Hypotheses 5 and 6 were supported as well, with significant standard coefficients of 0.335 and 0.395 and *t*-values of 3.607 and 4.475, respectively. This indicates that structure of representation had a positive impact on learner perceptions of both readability and memorability. The proposed research model explained 55% of the variance in readability and 65% of the variance in memorability.

Supporting Hypotheses 7 and 8, perceptions of readability and memorability significantly and positively affected learner preferences for using the extended e-learning system. Perceived memorability (standardized coefficient = 0.484, *t*-value = 5.502) influenced the preference to use the e-learning system more than perceived readability (standardized coefficient = 0.273, *t*-value = 3.792). The two factors explained 53% of the variance in the preference to use the e-learning system.

In summary, all effects in the model were significant except the effect predicted by Hypothesis 3, thus supporting seven of the eight proposed hypotheses. Learner preference for using the e-learning system was highly influenced by perceived readability and memorability, and perceived readability and memorability were significantly affected by the organization, consistency and structure of the representation. The only unsupported hypothesis was that representation consistency would positively influence perceived readability.

3.6. Discussion

The results showed that perceived readability and memorability predicted learner preference for using the e-learning system. E-learning success was measured by two sets of factors: the first consisted of two cognitive factors, and the second consisted of three distinctiveness factors. The two cognitive factors were the readability and memorability of the content representation as perceived by the learners. The distinctiveness factors were the representational characteristics of the e-learning interface; these factors included the organization, consistency and structure of the representation. The cognitive factors were used as mediators between the distinctiveness factors and the learner preference factor in the structural equation model. The structural model revealed the following:

(1) Perceived memorability was the most influential factor affecting learner preference for using the e-learning system. According to the standardized coefficient values in the path from perceived

memorability to preference for the e-learning system, memorability accounted for 64% of the total impact.

(2) Perceived readability represented 36% of the total effect on preference for using the e-learning system.

(3) Perceived readability and perceived memorability both had a significant impact on learner preference for using the e-learning system.

(4) The three environmental factors significantly affected perceived memorability. These perceptions were highly influenced by the organization, consistency and structure of the representation. The representation structure was the most influential of these factors, accounting for 46% of the total effect.

(5) Perceived readability was significantly affected by the organization and structure of the representation.

(6) Consistency in the representation did not influence perceived readability.

Previous research has identified a need for further investigation into how interactive representations will contribute to human–computer interaction in the future. There is, however, a noticeable shortage of studies that measure the effect of system representation on the ability of users to remember content (Bateman et al., 2010). Bateman reported that representations should reduce visual embellishments that are not essential to the content being presented. Studies such as those conducted by Hollan, Hutchins, and Kirsh (2000), Cosley, Lam, Albert, Konstan, and Riedl (2003), and Bateman et al. (2010) provided the main motivation for this investigation.

Our proposed research model revealed significant relationships between system representation and perceived readability and memorability. The model also shows how a user's perception of his or her ability to read and remember content contributes to his or her e-learning system preferences. This study also supports Botta's (2010) claims about the effect of structure on the ability to remember content.

Some researchers have focused on the effects of a system's display on users' decisions and their preferences for using a system (e.g. Cosley et al., 2003; Hackman & Walker, 1990; Kersten & Noronha, 1999; Wigdor, Shen, Forlines, & Balakrishnan, 2006). For example, Hackman and Walker (1990) found that clear representation, along with social presence, significantly affects perceived student learning. Cosley et al. (2003) note that the effect of the interface in a representation is much less studied. They further explore how system-supported representation in the information domain affects a user's decision to use a system. Our results show that the representation of online content supported by specific design elements positively influences the ability of students to read and remember content. In accordance with the von Restorff effect, we embedded content in isolation. The isolations were incorporated into segments or objects of the system's representation. This helped to make the main elements contribute to the structure, organization and consistency of the system's representation. This in turn led us to conclude that the more familiar a user becomes with the representation in an online context, the more the user will orient himself or herself toward active learning, thus reinforcing the preference for using the system. This result supports Halverson (2002) and Hollan et al. (2000), who suggest that insights concerning the manner of representing information must be divided into agents coupled with the individual environment by fully exploiting them in the interface design. It also supports Marsh's (1997) argument for classifying content into hierarchical nodes to improve recall.

This study enriches the theory of the von Restorff effect by showing that organization, consistency and structure that favour distinctiveness in representation can influence a user's decision to use a system, mediated by the effects of perceived readability and memorability. Our focus, however, was on the variables that mediate the relationship between representational elements and the user's e-learning system preferences. We also consider the findings to be in line with other previous studies on memory isolation, such as Fabiani and Donchin (1995), Fabiani, Karis, and Donchin (1990) and Markman and Gentner (1993).

4. Conclusion

This study assessed the effects of content representation in e-learning systems and its impact on preferences for using such systems. An e-learning system was developed that emphasized the design elements of organization, consistency and structure. A model was developed that incorporated isolation and distinctiveness based on the von Restorff effect. Positive correlations were found among the elements studied, and perceived readability and memorability were the key factors that contributed to these correlations. We found that incorporating cognitively isolated elements in a system's representation can influence the ability to read and remember content, which in turn influences the user's preference for using the system.

This research was found to be consistent with other recent studies on information representation and system design. Thus, it provides a useful background and recommendations for system designers in developing their representations. Our study is also the first to provide evidence regarding the influence of different representational features on user perceptions of memorability.

These findings could have far-reaching implications. First, designers of e-learning systems for universities can use these findings as guidelines to attract more students to online courses. Second, the findings highlight the fact that, in the absence of face-to-face communication, it is easy for students to become confused or lost in complex course structures, making interaction with the content more difficult. Course designers should keep this in mind and strive for both simplicity and redundancy in their system representations.

This study contributes to the literature by investigating the effects of design organization, structure and consistency on student perceptions of readability and memorability in e-learning representation. These effects have not been previously tested.

Finally, this study was limited to the organization, structure and consistency of the representation. Future studies should therefore investigate the effects of other design elements in e-learning representation, such as alignment, affordance, mapping, etc. Such studies should consider how these elements can foster the cognitive ability of students to learn and understand content in e-learning systems. In addition, future studies could include the collection of effectiveness data with a view to counteract the subjectivity of self-reported data, such as the ones which are used in this study.

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