

# Development of Chemical Bond Website for Field Dependent and Field Independent Learners

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**Abstract**—There has been an increase growth in the study to cater for individual differences in online learning. Web-based learning offers several benefits over conventional classroom include; it is no longer limited by time and space, the materials present are easy to update and it can integrates multimedia elements such as audio, animation and video. However, to add a value to this type of learning, the different characteristics of learners should be emphasized. Previous research indicated that individual differences have a significant influence with web based instruction. Therefore, it is important for designers and instructors to take into account about this factor when developing learning materials. Particularly, among various types of individual differences, cognitive style has been widely discussed in education studies. This paper discuss the development of Chemical Bond website for both learners which are field dependent and field independent by considering their characteristics.

**Index Terms**—Online learning, cognitive styles, field-dependent, field-independent.

## I. INTRODUCTION

Technology-based tools must be accompanied by an appropriate pedagogy to ensure that the teaching and learning processes become more effective [1]. According to Ally [2], online learning can cater for individual differences by providing appropriate learning activities based on the learners' characteristics and learners' preferences. Because, by paying attention to learner diversity, it will increase the student's motivation to learn and improve their learning performance [3]. For these reasons, research into individual differences has become an important issue over the past decade. Individual differences have been examined by researchers and include issues such as cognitive style, gender difference, learning style and prior knowledge. Among these differences, cognitive style is the most pertinent factor because it refers to a habitual approach to process information [4]. In order to design instructional strategies for efficient learning, cognitive styles of the students should be assessed and the different requirement should be identified to improve students' learning outcomes [5]. When the differences characteristics of learners' were identified,

functionality and learners' satisfaction will be increased [6].

## II. COGNITIVE STYLES IN ONLINE LEARNING

Cognitive style is one of the learners' characteristics that refers to their preferred way to process information and it is also considered as individual differences indicator. There are a lot of cognitive styles dimensions such as wholist-analytic, convergent-divergent and field dependent-field independent. Among the various dimensions of cognitive styles, Witkin's Field Dependence has been intensely examined in previous education studies. Witkin with his friends [7] proposed two types of cognitive styles which are field dependent (FD) and field independent (FI). These two types of cognitive styles are the most frequently examined by researchers. Else, these two types of cognitive styles have their own ways of perceiving, processing and storing information. When a learning process occurs, it involves the reorganization, integration, and creation of new mental structures. These are related to learners' cognitive style, where learners are different in their way of organising and processing information.

The use of a computer or technology in the process of teaching and learning is expected to apply higher cognitive skills such as collecting, analyzing, evaluating, summarizing and synthesizing information. However, learners using technology-based tools may have difference background, preferences and skills. Those aspects have been the major challenge for educational technologists and instructional designers to take account of individual differences especially cognitive styles [8], [9]. Previous researches proved that matching learners' cognitive style with the design on web-based learning will be increased students' learning performance [9], [10]. Several researches also indicated that difference cognitive styles require difference navigational support [11], [12]. Kim [13], in a study to measure the different behaviour of these cognitive styles in online learning found that field dependent learners depend much on "search" tool, used "home" key more often and tended to be distracted easily. In contrast, field independent learners are more effective and efficient in their way to search information. Recently a study conducted by Chen [11], to study the learners navigation tools usage showed that FI learners preferred "alphabetical index" and "find topic" tool. Compared to FI learners, FD learners favored "hierarchical maps" to help them explore the information and "where I am" function to avoid them from being lost in the website. Beside, a study conducted by Lee et al. [14] found that field dependent students preferred linear learning in online instruction while, field independent students used non linear

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learning. FD learners prefer linear format or guided navigation unless they tend to face difficulties in unstructured environment. Conversely, FI learners prefer free navigation and enjoy exploring new information by their own. Thus, the understanding of these two type of cognitive styles will provide a guide to design an effective online learning tool [15]. Several researchers listed the differences for field dependent learners and field independent learners when they learned via online learning (see TABEL I).

TABLE I: FIELD DEPENDENT VERSUS FIELD INDEPENDENT PREFERENCES TOWARDS ONLINE LEARNING

Authors	Learners' Preferences	
	Field dependent (FD)	Field Independent (FI)
Liu and Reed [16]	Tended to follow the sequences provided by the system	Tended to jump freely from one point to another
Dufresne and Turcotte [17]	Preferred a structured navigation tools and fixed browsing patterns	Favored a non-structure navigation tools
Ford and Chen [12]	Preferred the use of map	Favored the use of index
Chen [18]	Used passive and limited exploration	Used active approaches in their exploration
Magoulas, Chen and Dimakopoulos [19]	Preferred the content is organized in many main categories and fewer subcategories	Favored a small number of main categories with many more sub-categories.
	Preferred a global view of information	Favored a detail and analytical information
Chen [11]	Preferred breadth-first navigation path	Favored depth-first navigation path
	Preferred main categories and their relevant sub-categories on different pages	Favored categories and their relevant sub-categories on the same page
	Needs a global with anchor type for navigational support	Needs a flexible with guidance type for navigational support

Field dependent and field independent learners have been found to be successful in learning when the preferences of their cognitive style are matched [9]. Hence, to add a value in online learning, it is essential for designers and instructors to provide personalized aspect for students by considering their cognitive styles' characteristics. In this reaserach we presented a web-based learning for learning chemical bond (figure 1) that has been developed based on field dependent and field independent characteristics. Multimedia elements such as animations were employed to show different representations of chemical bonding. This is hope to help students understanding more about chemical concept involved in the bonding process.

### III. CHEMICAL BOND WEBSITE

In this website, several animations were developed to explain the process involved in ionic and covalent bonding. The animation was developed according to field dependent (FD) and field independent (FI) characteristics which are FD learners preferred a global view of information but FI learners favored details and sequences information.

For example the animation for FD learners, the information provided was presented all at once. The

animated electrons to show the formation of bonding and the explanation was appeared simultaneously (Fig. 2).

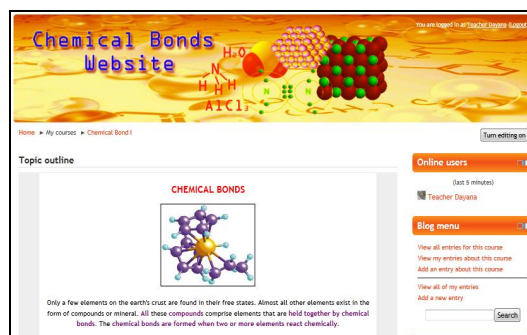


Fig. 1. Chemical bond website.

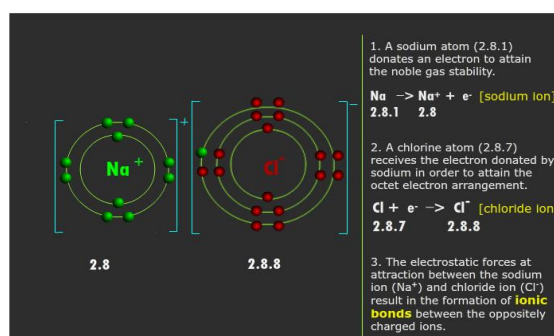


Fig. 2. The formation of sodium chloride for fd learners.

In contrast for FI learners, the information was explained in sequences and the animated electrons were presented one by one in order to give this type of learners an analytical explanation about the formation of compound (Figure 3).

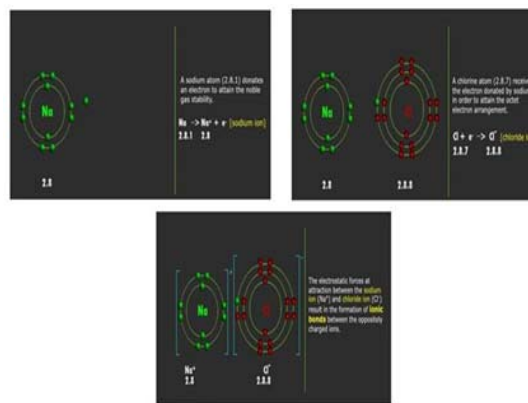


Fig. 3. The formation of sodium chloride for fi learners.

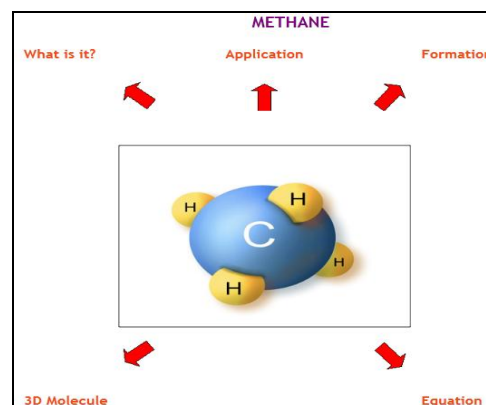


Fig. 4. The menu for FD learners.

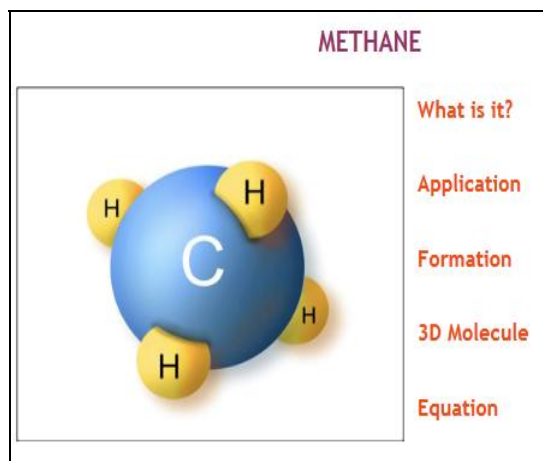


Fig. 5. The menu for FI learners.

On the other hand, the main menu for each of the compound also designed base on FI and FD characteristics. For FD learners, the main menu is displayed in the format of map (Fig. 4). However, for FI learners the menu is arranged in sequences or index (Fig. 5).

#### IV. CONCLUSION

This paper has demonstrated on how the principles for designing learning materials such as animation are possible for implementation. This study focuses for matching learners' cognitive style with the design of animations developed in the website. The developed website addressed the cognitive styles characteristics which are field dependent and field independent which proposed by Witkin *et. al.* [7]. This is aligned with statement by Chen [11] which stated that instructors or designers should consider different perspective of web-based design to suit the requirements of learners of both cognitive styles. For Lo *et. al* [20], emphasizing learners' cognitive style into web-based design can be beneficial to learning and this is proved by many previous researches. Thus, further research will be conducted to investigate the effectiveness of the developed website with achievement for both types of learners.

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#### REFERENCES

- [1] D. Laurillard, Rethinking university teaching: A framework for the effective use of educational technology. 2nd ed. London: Routledge. 2002.
- [2] M. Ally, "Foundations of Educational Theory for Online Learning". In *The Theory and Practice of Online Learning*. Terry Anderson. AU Press: Athabasca University. 2004, pp 15-44.
- [3] T. Larkin-Hein, and D. D. Budny. "Research on learning style: applications in the physics and engineering classroom." *IEEE Transactions on Education*. 44 (3), pp. 276-281. 2001.
- [4] S. Y. Chen, and X. Liu, 2008. An integrated approach for modeling learning patterns of students in Web-based instruction: A cognitive style perspective. *ACM Trans. Computer Human Interaction*. 15 (1).
- [5] K. H. Wang, T. H. Wang, W. L. Wang, , and S. C.Huang. 2006. Learning styles and formative assessment strategy: Enhancing student

- achievement in Web-based learning. *Journal of Computer Assisted Learning*. 22, pp. 207–217.
- [6] H. Ke, R., Kwakkelaar, Y. Taic, , and L. Chenc, Exploring behavior of e-journal users in science and technology: Transaction log analysis of Elsevier's ScienceDirect On Site in Taiwan. *Library & Information Science Research*. 2002. 24 (3), pp. 265-291
- [7] H.A. Witkin, C.A. Moore, D.R. Goodenough, and Cox, P.W. Field dependent and field independent cognitive styles and their educational implications. *Review of Educational Research*. 1977, 47, pp 1-64.
- [8] A. Altun, and M. Cakan, Undergraduate Students' Academic Achievement, Field Dependent/Independent Cognitive Styles and Attitude toward Computers. *Educational Technology and Society*. 2006. 9 (1). pp. 289-297.
- [9] S. Y. Chen, and R.D. Macredie. Cognitive style and hypermedia navigation: development of a learning model. *Journal of the American Society for Information Science and Technology*. 2002, 53(1). pp 3-15
- [10] H. W. Chou. Influences of cognitive style and training method on training effectiveness. *Computers and Education*. 2001, 37, pp. 11-25
- [11] L. H. Chen. Web-based learning programs: Use by learners with various cognitive styles. *Computers and Education*. 2010, 54, pp. 1028-1035
- [12] N. Ford and S.Y. Chen. Individual differences, hypermedia navigation and learning: An empirical study. *Journal of Educational Multimedia and Hypermedia*. , 2000, 9(4). pp. 281–312.
- [13] K. S. Kim. Effects of cognitive and problem-solving styles on the information-seeking behavior on the web. 1997. Retrieved from <http://www.edb.utexas.edu/mmresearch/Students97/Kim/intro.html> in 9/24/03
- [14] C. Lee, Y. W. Cheng, S. Rai, and A. Depickere, What affect student cognitive style in the development of hypermedia learning system? *Computers and Education*. 2005. 45(1). pp 1–19.
- [15] J. Lee. The effects of visual metaphor and cognitive style for mental modeling in a hypermedia-based environment. *Interacting with Computers*. 2007, 19, pp. 614–629
- [16] M. Liu and W. M. Reed. The effect of hypermedia assisted instruction on second-language learning through a semantic-network-based approach. *Journal of Educational Computing Research*. 1995, 12, pp. 159-175
- [17] A. Dufresne and S. Turcotte, Cognitive style and its implications for navigation strategies. In B. Du Boulay R. Mizoguchi (Eds.), *Artificial Intelligence in education knowledge and media learning system*. Kobe, Japan: Amsterdam IOS Press. 1997. pp 287-293.
- [18] S. A. Chen, cognitive model of non-linear learning in hypermedia programs. *British Journal of Educational Technology*. 2002. 33(4), pp. 449-460
- [19] G. D. Magoulas, S. Y. Chen and D. A. Dimakopoulos. Personalised Interface for Web Directories based on Cognitive Styles. *Lecture Notes in Computer Science*. 2004, 3196, pp. 159-166.
- [20] J. Lo, Y. Chan and S. Yeh. Designing an adaptive web-based learning system based on cognitive styles identified online. *Computers and Education*. 2011, 58, pp 209-222.



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