PERSONALIZED LEARNING ENVIRONMENT BASED ON COGNITIVE STYLES FOR MENTAL MODEL DEVELOPMENT IN LEARNING CHEMICAL BONDING

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ABSTRACT

The purpose of this research is to develop a personalized learning materials based on students’ preferences in cognitive style, which are Field Dependent (FD) and Field Independent (FI), in learning chemical bonds. The learning materials were designed and developed based on the characteristics of the cognitive styles and further integrated in the website. The effect of the website was investigated in order to promote students’ achievements, students’ mental model developments and their pattern of interaction while learning using the website. The pattern of interaction focused on five types of interaction, which are learner-instructor, learner-self, learner-learner, learner-content and learner-interface interaction. The research samples consist of Form 4 students from a school located in Johor Bahru. A combination of qualitative and quantitative methods has been employed in data collection and analyzing the research data. The findings show that students had a positive improvement in their achievement in learning chemical bonds. Beside, students had also developed a scientific mental model after learning using the website. Besides this, students categorized under FD showed the highest total hit of interaction and enjoyed using all the applications provided on the website as compared to FI students. This showed that the FD students were more active and socially orientated while learning using the website as compared to FI students. However, both types of students showed positive improvement in their achievement and in their mental model development. In conclusion, the focus on emphasising individual differences to promote students’ learning is a vital factor to be considered, as this aspect proves valuable for both students and teachers.

ABSTRAK

Tujuan kajian ini dijalankan adalah untuk menghasilkan bahan pembelajaran berasaskan gaya kognitif individu iaitu *Field Dependent (FD)* dan *Field Independent (FI)* bagi pembelajaran tajuk Ikatan Kimia. Bahan pembelajaran di rekabentuk dan dibangunkan berasaskan ciri-ciri gaya kognitif dan seterusnya di integrasikan dalam laman web yang dibangunkan. Kesan pembelajaran berasaskan laman web ini dikaji dalam membantu meningkatkan pencapaian pelajar, pembentukan mental model dan juga profil interaksi pelajar semasa belajar menggunakan laman web. Profil interaksi difokuskan kepada lima iaitu pelajar-pengajar, pelajar-diri sendiri, pelajar-pelajar, pelajar-bahan pembelajaran, dan pelajar-antaramuka. Sampel kajian ini adalah pelajar tingkatan empat dari sebuah sekolah di Johor Bahru. Kombinasi kaedah kuantitatif dan kualitatif digunakan dalam proses mengumpul dan menganalisa data kajian. Hasil kajian mendapati bahawa pelajar menunjukkan perubahan positif dalam pencapaian mereka dalam pembelajaran tajuk Ikatan Kimia. Selain itu, pelajar juga membentuk mental model yang sainstifik setelah melalui pembelajaran menggunakan laman web. Di samping itu, pelajar di bawah kategori FD menunjukkan jumlah hit interaksi yang tinggi serta menggunakan kesemua aplikasi yang disediakan dalam laman web berbanding pelajar FI. Ini jelas menunjukkan bahawa pelajar FD lebih aktif dan lebih sosial semasa belajar menggunakan laman web berbanding pelajar FI. Walaubagaimanapun, kedua-dua jenis pelajar ini tetap menunjukkan perkembangan yang positif dalam pencapaian dan juga pembentukan mental model mereka. Kesimpulannya, fokus dalam menekankan perbezaan individu dalam meningkatkan pembelajaran pelajar adalah menjadi faktor penting yang perlu diambilkira kerana aspek ini memberi kelebihan kepada pelajar dan juga guru.

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LIST OF ABBREVIATIONS

FD	-	Field Dependent
FI	-	Field Independent
GEFT	-	Group Embedded Figures Test
KBSM	-	Integrated Curriculum for Secondary Schools
PLE	-	Personalized learning environment

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Technology plays a fundamental role in making the teaching and learning process more effective. Roblyer (2003) has identified two changes when technology was integrated into the education system. The first change is the increasing number of references and tools that were used by teachers and students. The second change is the shift in learning strategies that the flexibility of computer technology affords. Traditional approaches usually involve learning being one-way or linear. Thus, the existence of computer technology in a classroom promises to change the passive learning approach to an interactive and dynamic learning process (Davies, Lavin, and Korte, 2008; Loch and Donovan, 2006). This is because the computer has great potential for enhancing teaching and learning outcomes (Fisher, 2010; Suchańska and Kęczkowska, 2007).

However, in recent years, the education field has moved rapidly towards implementing an online learning system. The implementation of web-based learning increased year by year until the launch of Web 2.0 in our education system. The characteristics of Web 2.0 have accelerated the changes in education and have also influenced the world by giving control of tasks to the learner (McLoughlin and Lee, 2010). Since learners were given authority to control their own learning, it is important to ensure that they engage and take that responsibility. In order to ensure that students affect their own learning, the differences between each learner must be taken into consideration. The consideration of individual differences will increase learners' motivation (Aviram *et al.*, 2008), give learners more interest in learning materials (Jung and Graf, 2008) and also give them the opportunity to construct, regulate and control their own learning (Johnson and Liber, 2008).

For the same reason, it is expected that a PLE will efficiently address learner needs and differences. The consideration of the diversity of individual differences brings forward the idea of a 'Personalized Learning Environment', or PLE for short (Olivier and Liber, 2001). A PLE, as defined by Gilbert and Han (2002), is personalized instruction that is tailored to learners' learning style, intelligence, interests and preferences. According to Downes (2007), the PLE and Web 2.0 are for creating connections, creating content and spreading control of resources. A PLE is also created as a means for individuals to control their own learning. This feature was the primary element in the PLE that allows learners to control the materials and content being presented, the look and feel of the learning environment and the interactions with other learners (Severance, Hardin, and Whyte, 2008).

PLEs have a number of benefits over traditional teaching and learning approaches. They create a learner-centric environment rather than a teacher-centred approach. This can be seen as an opportunity to improve learners' education process and allow them to engage actively in that process. For Green *et al.* (2005), the best PLE feature is when the students have the opportunity to interact with the learning objects that best fit with their needs. Therefore, the provision of learning materials that match students' needs and differences is a crucial factor in helping students learn more effectively, based on their preferences (Aviram *et al.*, 2008).

1.2 Background to the problem

The use of computers in the teaching and learning process has been a topic of discussion since the 1950s. Many researchers have proved the well-crafted use of computers in the learning process compared with traditional methods (Chen and Jones, 2008). This is because a computer will increase learners' effectiveness or performance, increase their efficiency and heighten their engagement in learning.

Other than that, the computer can also promote higher order thinking skills, such as analysing, making hypotheses and inferences or solving problems by engaging students in authentic, challenging, complex and realistic tasks (NCREL, 2002; Shankar, 2008).

Largely, nowadays, the learning process has been moving towards the application of online learning (Alessi and Trollip, 2001; Liaw *et al*., 2007; White and Weight, 2000). What differentiates between online learning and traditional learning is the method used; however, the objectives, materials, books and syllabus are the same. Online learning, as defined by Chang and Fisher (2003), is a system and process that connects learners with materials and information that are distributed online. According to Allan and Seaman (2010), online learning occurs when the content is obtained via the online environment. Typically, there are no face-to-face meetings in the classroom. Studies conducted by them showed that, in 2008, about 4.8 million students were moving towards online learning.

One of the popular online applications that have emerged for educational use is web-based learning. Many studies have shown web-based learning's benefits and the potential for it to enhance the teaching and learning process (Mistler-Jackson and Songer, 2000; Linn *et al.,* 2003; Clark, 2004). This is because the use of a website as an educational tool provides learners with a new learning experience and educators with an interesting teaching environment (Nam and Smith-Jackson, 2007). The popularity of web-based learning is due to the concept of learning "anywhere" and "anytime" (Oh and Lim, 2005; Neo *et al.,* 2008; Anido *et al.,* 2001). As mentioned by Killedar (2008), the web can be globally distributed and has highly personalized media for delivery information so the teaching process is no longer confined to a time and place. By using this medium, time and the physical boundaries of the traditional classroom no longer exist (Khalifa and Lam, 2002).

Since online learning has different settings from the conventional classroom, educators are required to use special techniques to ensure that students learn best, based on their preferences. Therefore, educators require an understanding of the characteristics of the learners that might affect how they interact with the learning environment. This also helps educators to design an appropriate learning environment based on students' differences. Alomyan (2004) suggested the characteristics that educators must be concerned with, such as amount of prior knowledge of the learning domain, cognitive style, motivation, age, gender and so on. Once the profile of the learners is determined, the process of learning will be easily adapted to the student's needs.

Currently, to cater for all the individuals' differences in an online setting, a new concept called the Personalized Learning Environment (PLE) has emerged in the educational field. The PLE is a tool that allows learners to engage in a distributed environment consisting of a network of people, services and resources (Downes, 2006). The PLE is a new approach in designing and developing online learning instruction and is focused more on individual learning rather than the instructor, facilities, resources and tools. The PLE also plays an active role in improving the effectiveness of learning (Li and Gu, 2009). According to Atwell (2006; 2007), the PLE is an environment that is constructed by the individual and they are responsible for their own learning process. They also need to manage the process of learning effectively and take a larger stake in the ownership of content. In general, the personalized learning approach has the potential to meet educational needs in the future as well as providing a new way to encourage students to learn (Bentley and Miller, 2004).

1.2.1 Personalization and individual differences issues in online learning

Online learning has changed the ways in which education has been conducted. Unfortunately, many educational websites do not employ the principles of effective learning (Cook and Dupras, 2004). Wijekumar (2005) claimed that the web-based learning environment is a great educational tool only if it is well designed. The critical selection of learning strategies to ensure the learning takes place and how students can reflect on their learning process are examples of challenges for educators in designing an effective website (Trinidad, 2003). Hence, according to Johnson and Aragon (2003) the powerful online learning environment should consider seven aspects, which are (1) address individual differences, (2) motivate the student, (3) avoid information overload, (4) create a real-life context, (5) encourage social interaction, (6) provide hands-on activities, and (7) encourage student reflection. For Magoulas *et al.* (2003), he stresses that the importance in designing web-based instructions is to accommodate individual differences amongst learners.

Many researchers claimed that the main problem with the online learning environment is the aspect of the lack of personalization (Martinez, 2000; Cristea, 2004; Rumetshofer and Wöß, 2003; Teo and Gay, 2006; Tomei, 2008; McLouglin, 1999; Ayersman and Minden, 1995). Thus, one of the key issues of concern in today's learning is individualised learning (Wang, 2004; Santally and Senteni, 2005). According to Wang (2004), individualised learning is a learning model that places the student (learner) at the centre of the learning process. Students are active participants in their learning, which means that they learn at their own pace and use their own strategies. Thus, students are more motivated and their learning is more standardised. In addition, individual learners will take advantage of self-paced learning environments in which they have control over their pace of learning, information flow, selection of learning activities and time management (Jung, 2001).

There are many controversial issues related to the effectiveness of online instruction. Researchers claimed that online instruction lacks the ability to satisfy the diverse learning needs of online learners (Oh and Lim, 2005). Brusilovsky (2001) claimed the main problem in exploiting information in web-based learning is to determine which attributes should be used and how to attend to diverse types of learners. Chen *et al.* (2008) and Huang and Yang (2009) stated that most online learning materials are rarely designed to suit learners' differences. As a result, learners tend to be ineffective in their learning process.

According to De Vita (2001), the concept of individual differences gives a challenge to educators and instructional designers to design the quality of learning materials. Moallem (2007) stated that the learning materials that match learners' styles tend to help learners to retain information for longer. Hence, identifying different types of learner variables and their impact on student learning has been a major area of study in online instruction (Saeed *et al.*, 2009). Donmez, Simsek and

Arikan (2010) also agreed with this, stating that knowing about learners is one of the vital factors for successful online instruction. This is because students will be able to achieve their learning goals if the pedagogical procedures are adapted to their individual differences (Federico, 2000).

When individual differences among students are being considered, the term Personalized Learning Environment (PLE) arises. Siemens (2007) defined the terms as

"…a collection of tools, brought together under the conceptual notion of openness, interoperability and learner control…PLEs are comprised of…the tools and the conceptual notions that drive how and why we select individual parts…"

Attwell (2007) stated that a PLE is a learning environment that gives an opportunity for learners to manage their own learning. In a PLE environment, the learner is accentuated in organising, customising and shaping the learning environment (Downes, 2005). It is focused on learners taking responsibility and having control over their learning, rather than being controlled by the instructor (McLoughlin and Lee, 2009). Compared with traditional learning, the PLE is more responsive to learners and considers their needs and preferences (Chatti *et al.*, 2010). Besides, traditional learning, with its 'one size fits all' learning approaches, often fails to address the differences, needs and preferences amongst learners. Thus, Jafari *et al.* (2006) suggested learners should have a learning system that provides them with what they want and need. Hence, by using personalization it can adapt to the variety of characteristics of the students.

Research into individual differences and needs has become an important issue over the past decade. Lee (2001) believes that individuals adapt differently in web-based learning. Thus, it is expected that enhancement of the learning process can be achieved by recognising students' learning needs, the diversification of their learning styles and students' preferences with respect to specific learning processes. Investigations of student learning preferences have shown that among the variables that influence the success of learning are:- cognitive style (Chang, 1995, Liu and Reed, 1995; Reed and Oughton, 1997; Ford and Chen, 2000; 2001; Kim, 2001; Chen and Paul, 2003; Alomyan, 2004), learning style (Ford and Chen, 2000; Santally, 2003), prior knowledge (Hölscherl and Strubel, 2000; Foster and Lin, 2003) and gender (Felix, 2001). Among these preferences, cognitive style and prior knowledge are commonly addressed as the individual differences in the previous research (Chen and Paul, 2003; Alomyan 2004).

1.2.2 Cognitive style as one of the individuals' differences

Searching for information in online settings nowadays is a skill with which most students should be familiar. Previous research suggests that the skill of searching for information is related to cognitive style (Graft, 2003). Cognitive style is also one of the individual differences that is taken into account in research studies currently (Ford and Chen, 2000; 2001; Kim, 2001; Chen and Paul, 2003; Alomyan, 2004; Dag and Gecer, 2009). According to Webster (2001), cognitive style is more deep-seated in an individual's personal and psychological behaviour. Cognitive style, as stated by researchers, is a fundamental individual difference, which relates to the preferred ways of organising and processing information and experiences (Chakraborty, Hu and Cu, 2005; Martinsen and Kaufmann, 1999; Pencheva and Papazova, 2006; Riding and Rayner, 1998; Sadler-Smith and Badger, 1998). Riding and Rayner (1998) defined cognitive style as how an individual preferred, and habitually approached, to organise and represent information. Riding (2002) claimed that cognitive style affects the ways in which events and ideas are viewed, affects how a person may respond to those events and ideas, how a person thinks about them and how a person makes a decision.

In a hypermedia system, it is important to clarify the individual's differences, such as cognitive style (Ruttun, 2009). Among other differences, cognitive style is vital because it refers to the manner in which information is perceived and processed. Many researchers have argued cognitive style as being one of the most important factors that might affect learners' performances, especially in computer based systems (Andris and Stueber, 1994; Ayersamn, 1993; Chang, 1995; Leader and Klein, 1996). Researchers also revealed that students with different cognitive styles showed different learning preferences and required different navigational support in hypermedia systems (Chen and Ford, 2000). Therefore, this became a challenge to educators to consider learners' cognitive styles when integrating information and communication technologies in a learning environment (Altun and Cakan, 2006).

Cognitive style also has a significant effect on the learning process (Cakan, 2000; Ibrahim *et al.*, 2004) because learners with different cognitive styles have a different ways of processing information. Students with high cognitive ability are assumed to be able to engage in the learning process and it also influences students' intellectual abilities, skills and personalities (Danili and Reid, 2006). According to Cakan (2000), cognitive style is one of the significant factors that may influence students' achievements in various subjects. A study conducted by Tinajero and Paramo (1997) to investigate the relationship between cognitive styles and students' achievement in several subjects, such as Science, English and Mathematics, found that field independent students performed better than field dependent students. Thus, it is the educators' responsibility to consider the students' cognitive differences when involving them in the teaching and learning process, especially in the subject of Chemistry (Ibrahim *et al.*, 2004).

1.2.3 Cognitive style in learning Chemistry

In the study of Chemistry, the learning process is not just about memorising facts but more about the application of the facts in students' daily lives. The process of teaching and learning Chemistry should emphasise the students' ability to think about what they have learned about the chemical concepts and try to apply it in a real situation. This is consistent with the aim of Chemistry education, which stated:

"…Chemistry curriculum aims to generate students with knowledge and skills in the chemistry field and to be able to apply the knowledge and skills based on scientific attitudes and values to make decisions and solve problems in daily life."

(Pusat Perkembangan Kurikulum, 2001)

Generally, each student has different abilities and capabilities from another student. These differences include what their attitudes towards learning are, how they process information and how they respond to the learning. These differences may be influenced by their differences in types of cognitive styles. Chemistry requires students to visualise and imagine molecules when it involves the use of a model. According to Madar and Buntat (2008), the visualisation ability has a close relationship with cognitive style. Thus, students with different types of cognitive style have their own sensitivity and visualisation ability when involving the use of models in learning Chemistry. This was proved by Bailey and Garratt (2002), who that found different cognitive styles among students placed a variety of different interpretations into their lessons.

Moreover, Niaz (1987) claimed that cognitive style plays an important role in Chemistry, especially in problem solving tasks. A study conducted by Yusuf and Noraini (2010) proved that students with different cognitive styles showed different patterns when solving the given Chemistry task. For example, Field Independent (FI) students tend to analyse the questions and focus more on the given items. Field Dependent (FD) students easily understood the questions given at first but, in the end, they tended to have a problem in structuring the information again.

Other than that, cognitive style also plays an important role in Chemistry achievement (Macnaught, 1982; Tinajero and Paramo, 1998; Gerald, 2002; Danili and Reid, 2004; 2006; Bassey *et al.*, 2007; Stamovlasisa *et al.*, 2010). Therefore, according to Bassey (2007), there was a need to implement the recognition of students' cognitive styles for proper understanding in the study of Chemistry. He also strongly suggested that Chemistry teachers should show greater interest in teaching this subject, using cognitive style as a way of motivating students to learn. As suggested by Ibrahim *et al.* (2004), in order to enhance the Chemistry learning process, an investigation into the students' cognitive styles should be carried out.

1.2.4 Difficulties in learning Chemistry

Many researchers reported about students' difficulty in learning Chemistry. Students regard Chemistry as a difficult subject because it involves many abstract concepts and the concepts are difficult to visualise. This is supported by Sirhan (2007), who claimed that Chemistry knowledge is closely related to abstract concepts and this makes it difficult for students to learn. For Stief and Wilensky (2003), Chemistry contains many abstract concepts and requires complex concepts that are not applicable outside of the classroom. According to Taber (2002), students need an imagination and higher order thinking to learn and be proficient in chemical concepts. An understanding of chemical concepts is not only about knowing what happened, but students should also know how to apply them and explain them clearly and easily. These are the difficulties faced by students when they learn Chemistry (Sirhan, 2007).

However, it is a fact that chemical knowledge is represented at three levels, which are called sub-microscopic, macroscopic and symbolic levels (Ozmen, Ayas and Costu, 2002). These three levels are linked with each other in the *Chemistry Triangle* (Johnstone, 1991; Gabel, 1992; Harisson and Treagust, 2000; Ebenezer, 2001; Ravialo, 2001; Treagust *et al.,* 2003) (refer Figure 2.1). There are interactions and distinctions that exist between these three levels and it has become an important factor for Chemistry students to be skilled in the chemical concept. To understand the chemical concept it is necessary for students to make a connection between the three levels (Ozmen, 2008). However, students live and imagine in the macroscopic level and this causes them difficulty in following the shifts between the macroscopic and microscopic levels (Johnstone, 1991; Gabel, 1996; Harrison and Treagust, 2000; Tsaparlis, 1997; Robinson, 2003).

It is equally true that one of the most challenging features in learning Chemistry is the difficulty in visualising chemical compounds in the three chemical representation levels. Many researchers reported that students generally understand chemical phenomena at macroscopic level and are able to interpret at the symbolic level only (Hinton and Nakhleh, 1999). Conversely, students are often unable to make a link between those two levels and the microscopic level (Jansoon, Coll and Samsook, 2009). In order to integrate the three levels of representation, students need to confront two situations. Firstly, they need to learn how to connect abstract representations (Wu, Krajcik and Soloway, 2001) and, secondly, they need to be exposed to abstract phenomena, which are difficult to interpret or visualise at the microscopic and symbolic levels (Johnstone, 1991). Robinson (2003) suggested students should have a deep understanding of how to convert a symbol to meaningful information. Only then will they be able to move towards quantitative information. This is because developing a conceptual understanding in Chemistry includes the ability to translate and represent chemical phenomena using macroscopic (observable), microscopic (particulate of matter) and symbolic forms of representation.

According to Davidowitz and Chittleborough (2009), Gabel (1996) and Nahum *et al.* (2004), teachers should help students to make a link between the three levels. Abdoolatiff and Narod (2009) stated that the most difficult challenges in teaching Chemistry involve conveying to students the three chemical representations when explaining chemical concepts. Thus, the teacher should provide physical examples and clear descriptions and depict the chemical diagram in colour to help students to understand and make a connection between the three representations (Davidowitz and Chittleborough, 2009). On the other hand, the use of computer-based technology, such as animation and simulation, is able to provide a powerful method for fostering chemical concepts as they can visualise simultaneous representations of the chemical phenomena (Abdoolatiff and Narod, 2009). As claimed by Tsaparlis (2009), students' difficulties in learning Chemistry may be attributed to the fact that the topic or concept has been traditionally taught in the classroom. Hence, when students are able to depict how the three levels are connected to each other, then they are able to generate comprehensible explanations (Treagust *et al.,* 2003) and generate relational understanding (Mulford and Robinson, 2002; Treagust *et al.,* 2003). These will help students in reducing alternative conceptions in developing scientific mental models.

1.2.5 Models and mental models in learning Chemistry

Models are important for understanding Chemistry (Coll, 2006; Nahum *et al.*, 2004). Models are used in all science subjects but they are particularly important in Chemistry because this subject involves so many complex and abstract concepts (Coll, 2006). According to Gilbert *et al.* (2000), one of Chemistry education's goals is to teach students how to interpret models, use them and understand the nature of the model. Justi and Gilbert (2002) stated that, by using models, the understanding of chemical concepts among students, and also the ability to produce their own chemical models, might be improved. Other than that, models also help students to make a link between scientific theories and practice (Gilbert, 2005).

Chemical bonding is one of the subjects that involves the use of models, varying from simple ones to sophisticated abstract models possessing considerable mathematical complexity (Coll and Taylor, 2002; Coll and Treagust, 2003). It is a topic that students commonly find to be problematic, developing a wide range of alternative conceptions (Ozmen, 2008) (see subtopic 2.5.1). The fact is that students cannot see how the atoms or elementary particles are held together, and how they interact and bond together to form a compound. This demonstrates that learners need to understand models in chemical bonding to be proficient in Chemistry (Coll and Treagust, 2003). In 2001, Coll and Treagust reported that students at secondary, undergraduate and postgraduate levels preferred simple and realistic mental models for chemical bonding despite being exposed to abstract, mathematically complex images. Students' misconceptions regarding these chemical bonding concepts begin when they live and operate in a macroscopic world and do not easily follow the shifts between macroscopic and microscopic levels (Harrison and Treagust, 2000). As a result, they tend to build a non-scientific mental model, which means that the idea is not aligned with scientific concepts (Taber, 2002)

Detevak (2005) developed a model called Interdependence of Three Levels of Science Concepts (ITLS) (refer Figure 2.2) to explain the connection between the concrete and the abstract level. In order to gain and build knowledge, students are encouraged to use their mental models to see the connection between all three levels

(Detevak *et al.*, 2004). According to Jansoon, Coll and Samsook (2009), the mental model represents ideas in an individual's mind used to describe and explain phenomena. It allows learners to engage in description, explanation and prediction. When students learn, especially in science subjects, they will gain knowledge of the scientific mental model through the teaching process (Harrison and Treagust, 2000). This means to say that students create their own mental model and try to understand the scientific knowledge when they are involved in the learning process (Chittleborough *et al.*, 2005).

When concerns about the three levels of representation in learning Chemistry are raised, a variety of instructional approaches, such as instructional technology (Ardac and Akaygun, 2004; Tasker and Dalton, 2006), laboratory activities (Chandrasegaran, Treagust and Mocerino, 2008) and concrete models (Copolo and Hounshell, 1995) have been used to help students understand Chemistry. For instance, multimedia tools, which integrate animations of molecular models, video clips of chemical equilibrium, or real time graphics, will provide students with opportunities to visualise chemical processes at the microscopic level. Furthermore, many studies (Ardac and Akaygun, 2004; Barnea and Dori, 2000; Sanger and Badger, 2001; Stieff, 2005; Tasker and Dalton, 2006; Tversky and Morrison, 2002; Wu, Krajcik and Soloway, 2001) found that students' benefits, when they learned using computer-based visual models to visualise chemical processes, occurred at the three levels of representations.

1.2.6 Computer-based learning to enhance learning Chemistry

Computer-based molecular modelling is a useful and flexible tool, which enables students to view representations or phenomena that are not visible to our naked eye (Aksela and Lundell, 2008). According to Aksela and Lundell (2008), via the computer, students have a fast and easy way to make use of visual models, supported by a verbal presentation. In addition, by integrating innovative technologies, such as the computer model, it gives exposure to the micro and macro world of chemical processes (Dori and Barak, 2000). Furthermore, Condie and

Munro (2007) also highlighted that computer technology can help to enhance the understanding of abstract microscopic concepts and processes in Chemistry.

For the chemical bonding subtopic, which involves the uses of models, Kozma and Russell (2005) suggested that molecular models, simulations and animations could aid in studying the concept of bonding. Frailich, Kesner and Hofstein (2009) also agreed, saying that simulation and animation can demonstrate models at the macroscopic and microscopic levels. Ardac and Akaygun (2005) found that students who learned with the aid of dynamic computer-based models have a better understanding of molecular representations compared with their peers who had no such experiences. Hence, the development of computer-based models to learn the three levels of representation in Chemistry is important in order to support the students' understanding of chemical bonding, as this tool has the capacity to support the multilevel chemical concepts that are not directly perceivable by other methods.

In light of the above discussion, it has been decided to emphasise the three levels of chemical representation (macroscopic, microscopic and symbolic) in conveying chemical bonding concepts in the present study. Thus, learning materials concerned with students' cognitive style characteristics and preferences will be developed. Additionally, by integrating this tool it is hoped to promote and help students to develop their scientific mental models in chemical bonding.

1.3 Statement of the problem

The need has arisen towards the consideration of individual differences when engaging learners in online instruction and, furthermore, in designing their learning materials. Catering to the differences amongst learners has become a crucial issue in order to ensure students engage effectively and promote their thinking in the learning process. As a result, meaningful learning will be efficiently adapted when learner differences are considered. Meaningful learning can be defined as a process in which new information is related to previous knowledge within the cognitive structure of the learner (Novak, 2002; Viola *et.al*, 2007). Nevertheless, the process of teaching and learning will be more meaningful when teachers know their students' unique styles, needs, preferences, strengths and weaknesses in learning. Hence, educators need to understand the individual differences between students, such as cognitive style. This is because individuals are different in their ways of seeking and processing information. Therefore, the PLE that has emerged in the education field recently tends to cater to the individual's differences, such as learning style, cognitive style, skills, prior knowledge and many more (Sampson and Karagiannidis, 2004)

Students have their own needs, preferences and characteristics and these are categorised as individual differences. Among the individual difference variables that are considered important is that of cognitive style. In the context of Chemistry, cognitive style seems to have a significant effect on students' achievements (Stamovlasisa *et al.,* 2010). However, Chemistry is one of the most difficult subjects to learn (Chittleborough, 2004). Many students regard Chemistry as being too abstract, too hard and too mathematical. As a result, students claim that the subject is boring (Gilbert, 2002) and they develop a negative attitude towards it. Once students have decided that something is going to be hard to learn, they end up with many misconceptions about the subject.

Chemistry has been found by many researchers to generate misconceptions among students. In fact, learning Chemistry is not easy, as many people think, even though Chemistry concepts are related to our daily life. Brousseau (2005) claimed that the abstract nature of Chemistry and its three levels, macroscopic, microscopic and symbolic, are the causes of difficulty in learning it. The macroscopic level refers to observable phenomena, or things that we can see, touch and feel. Chemical representation at the microscopic level refers to chemistry concepts behind the phenomena, and these are often abstract. The symbolic level is used to represent chemistry concepts, such as symbols, formulas and structures. Mbajiorgu and Red (2006) stated that these three levels are the main reason why students find Chemistry difficult. These authors also claimed that the interaction between these three levels requires learners to manipulate chemistry concepts in order for understanding to take place.

One of the Chemistry topics that require students to understand the three levels is the Chemical Bond. In science education literature, there have been numerous studies to determine students' understanding and misconceptions about chemical bonding. According to Harrison and Treagust (2000), students' misconceptions of this topic start with the fact that they live in macroscopic matter and cannot follow the shift between the macroscopic and microscopic levels. As a result, students tend to build nonscientific mental models. Other than that, Ozmen (2004) also stated that chemical bonding involves the use of a variety of models, from simple, analogical models to sophisticated, abstract models. In fact, the use of models is dominant in the subject of Chemistry (Nahum *et al.*, 2004). When students are exposed to the use of models, they will form a mental model as a result of the learning process (Harrison and Treagust, 2000). However, the difficulties arise when students are not able to explain the shift of chemical representations in the Chemistry triangle and, at last, they will develop a non-scientific mental model (Taber, 2002). In a study conducted by Coll and Treagust (2001), with secondary, undergraduate and postgraduate students, they found that all respondents were able to explain the concept of bonding with a simple explanation only. In addition, they found that the learners' mental models of bonding became sophisticated and complex when they were asked to explain more detail about the formation of bonding.

As a conclusion, research into individual differences, in cognitive styles and also in the difficulties of learning Chemistry related to chemical bonding, are widely accepted among the educational researchers. All of these three issues have their own problems and crises. However, there is still little research focussing on these three aspects together in online learning. Thus, to put it briefly, this study was designed to focus on cognitive styles and the students' personalized aspects, with the web-based learning environment as the platform for the students to learn chemical bonding. In addition, more research only focused on the effect of cognitive styles on students' achievements. For that reason, the aim of this research is to design and develop chemical bonding learning materials based on cognitive style characteristics and to investigate further the effect on students' mental model development and their interaction pattern while learning using the website.

1.4 Objectives of the study

The objectives of this research are:

i. To design and develop a Chemistry website for the chemical bonding subtopic based on the students’ cognitive styles, which are field dependent and field independent (Witkin, 1971).

ii. To investigate the influence of a cognitive style based website (field dependent and field independent) in promoting students’ achievements in:
    a. Learning the chemical bonding topic
    b. Development of the mental model in chemical bonding

iii. To study the development of the mental model for field dependent and field independent students while learning using the website.

iv. To examine the pattern of interaction for field dependent and field independent students while learning using the website and its contribution towards the mental model development.

1.5 Research questions

The research questions of this study are:

i. Is the cognitive style based website influential in promoting students’ achievements in:
    a. Learning the chemical bonding topic?
    b. Development of the mental model in chemical bonding?

ii. What is the development of the mental model for field dependent and field independent students while learning using the website?

iii. What is the pattern of interaction for field dependent and field independent students while learning using the website and how does it contribute to the mental model development?

1.6 Theoretical framework

The theoretical framework is presented in Figure 1.1. The PLE forms the learning environment being implemented of this research. As mentioned by Freitas and Yap (2005), today the "one size fits all" approach has changed to a more personalized approach to meet the individual's needs and preferences. The belief that individuals learn differently is one of the main considerations of the modern theories in education nowadays. Hence, the focus on individual needs illustrates the clear connection between the PLE and individual differences amongst learners.

Cognitivist and constructivist theorists have considered learning and instruction related to individual differences (Yecan, 2005). According to Sampson, Karagiannidis and Kinshuk (2002), the PLE also evolved from both of these theories. Many studies were conducted to find out how individuals' differences affect the learning process in the online setting (Yecan, 2005). Chen and Paul (2003) stated that, nowadays, the pattern of research has shifted from investigating how web-based instruction affects students' achievements to being more focused on how individual differences affect the learning process and the environment as well.

When individuals learn in a hypermedia environment, they are engaged in constructing knowledge that is focused on how they organise and process the information. This ability is related to their cognitive style (Chen, 2002). Cognitive styles are also considered as one of the individual differences that were found to be important and have significance for students' learning, especially in a hypermedia environment (Chang, 1995; Yecan, 2005; Lee and Boling, 2008).

In this present research, the cognitive styles defined by Witkin *et al.* (1971) of being field dependent (FD) and field independent (FI) are chosen. According to Fitzgerald and Semrau (1998), the FDI is one of the factors contributing to the development of operative schemata in individuals' cognitive structure, which is one of the stages in the mental model (Jonassen, Beissner and Yacci, 1993).

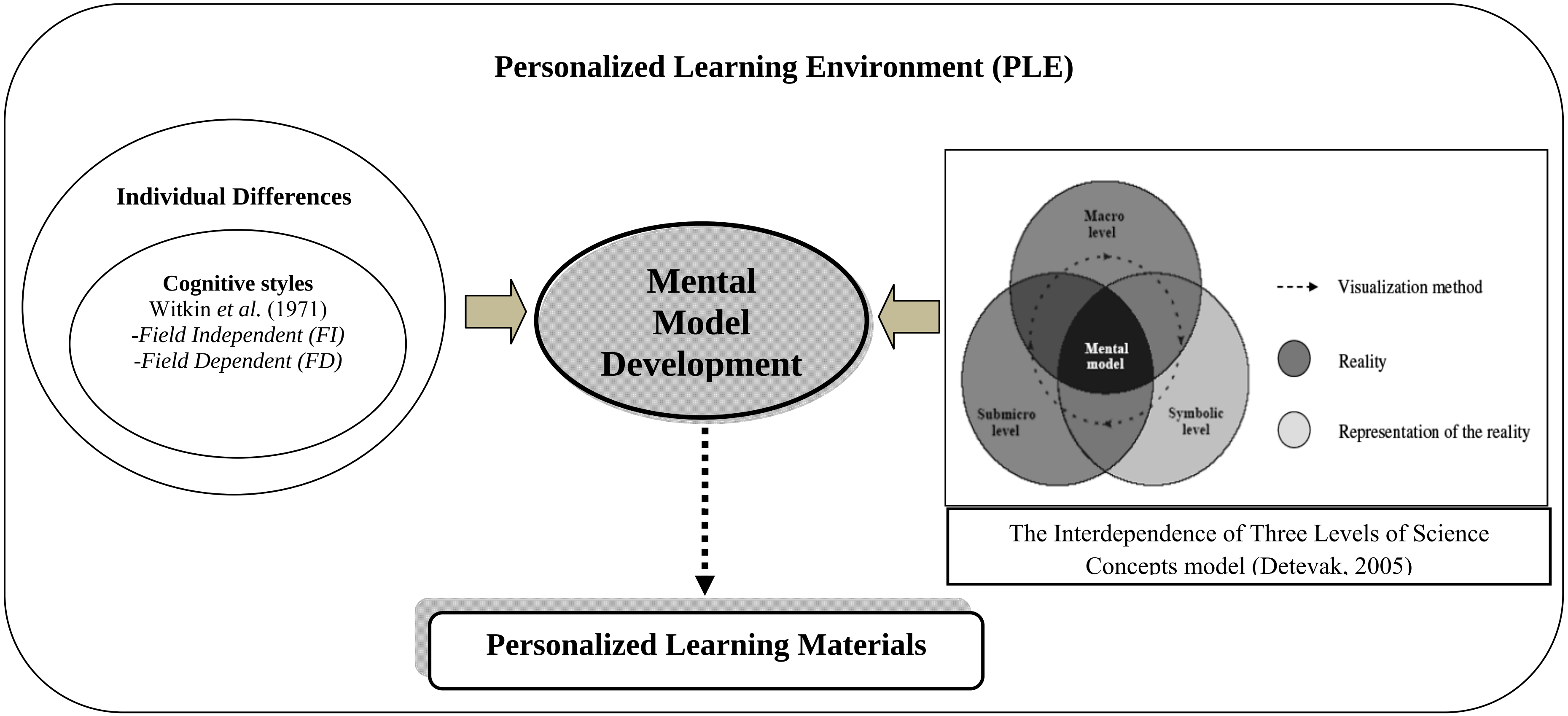

Figure1.1: Theoretical Framework

In a Chemistry context, the mental model is a personal representation in integrating the macroscopic, microscopic and symbolic levels. A model called the Interdependence of Three Levels of Science Concepts (ITLS), developed by Detevak (2005), illustrates the connection of these three levels in chemical representation for developing a mental model. According to Detevak (2005), learners will develop their mental model when they are able to see the connection between the three levels in chemical representations.

Therefore, by considering all these aspects, personalized learning materials will be the expected outcome, catering for cognitive style characteristics in order to promote the development of the mental model in the three levels of chemical representations (the macroscopic, microscopic and symbolic level).

1.7 Research Framework

This research were conducted according to the reseach framework illustrated in Figure 1.2. Initially, the characteristics of the field dependent (FD) and field independent (FI) types of cognitive style were investigated. The characteristics were then considered in the design and development process of the learning materials on the Chemical Bond website. Prior analysis has explained that the development of the mental model among students in learning Chemistry depended heavily on the students' understanding of the three levels of chemical representations, the macroscopic, microscopic and symbolic levels. Detevak (2005) claimed that the scientific mental model would be developed if students were able to see the connection between those three levels and, furthermore, able to explain the shift between it. Thus, the Chemical Bond website is developed for the purpose of promoting the development of the mental model in chemical bonding by considering students' cognitive style characteristics as their personalized aspect.

In the implementation phase, the developed website is used by students to learn the chemical bonding topic. From this process, the research expected to investigate the students' achievements in learning chemical bonding and the mental model development in this topic. Instead of that, upon the implementation of the website, the students' weekly mental model development is investigated deeply and the students' log data is obtained. Finally, the influence of the website in promoting the students' achievements and development of the mental model in chemical bonding is investigated in the evaluation phase. Furthermore, the data in the students' log files is further analysed to construct the pattern of interaction for both types of students (FD and FI).

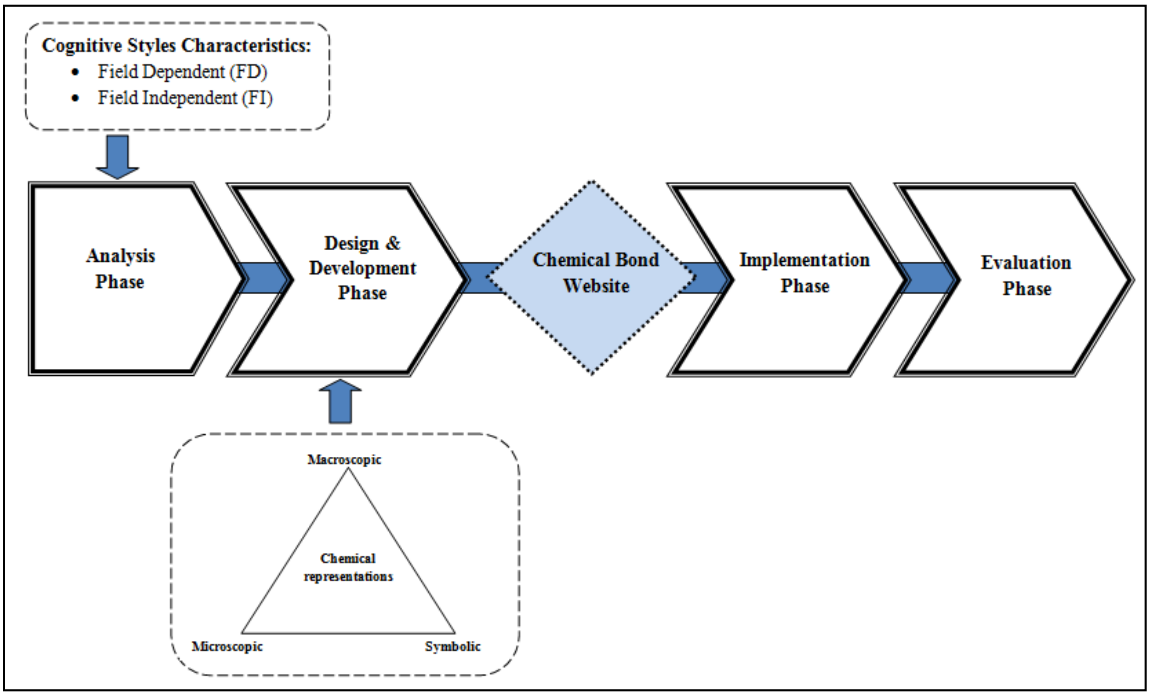

Figure1.2: Research Framework

1.8 Rationale for the study

For this study, the aim of applying the concept of PLE is due to the emergence from Web 1.0 to Web 2.0. The characteristics of Web 2.0 emphasise the concept of learning not being limited to time, place and other restrictions but tailored to individual needs, knowledge, interests and background (Sampson and Karagiannidis, 2002). In addition, the Web 2.0 features provide opportunities for students to control their own learning process (Dron, 2007) and this advantage is consistent with the characteristics of the PLE concept. Furthermore, the PLE concept may satisfy learners according to their needs, preferences and characteristics.

There are varieties of individual differences that can be considered by educators in providing the learning environment more effectively. However, the cognitive style is the most addressed individual difference indicator by researchers. Cognitive style is one of the preferences that have an impact in the process of decision-making and creative cognitive processing (Steele, 2003). In learning a science subject, such as Chemistry, cognitive style affects an individual's personality and the psychological behaviours that indicate how learners perceive, interact and respond to the learning environment (Fatt, 2000). Accordingly, cognitive style also has an impact on learners' performance and achievement in Chemistry (Danili and Reid, 2006).

Since students regard Chemistry as an uninteresting subject and one that is difficult to learn, especially in interpreting chemical processes at a macroscopic, microscopic and symbolic level, educators need to apply an effective strategy in their teaching process. This will help students to become proficient in the chemical concept. Empirical evidence has documented that educators can make Chemistry lessons more interesting and exciting by using multimedia teaching materials, which are inherent with the potential to visualise abstract concepts in Chemistry. Thus, when students are able to visualise those three levels in order to explain the process involved, they may end up with an appropriate mental model.

Therefore, the relevance of this study is to focus on the chemical bonding subtopic, because of the past studies that have proved that there are many difficulties faced by students, as well as the need to form a mental model that is consistent with the concept of science. Hence, the idea of doing this research on the development of mental models, particularly in the chemical bonding subtopic, is based on the facts and the evidence from previous studies. Additionally, the implementation of the concept of personalized learning, with the focus on the cognitive style aspect, hopes to provide an effective learning environment for the students as well as to improve their performance.

1.9 Importance of the study

The importance of this study is to all people who are involved in the process of teaching and learning. They are:-

1.9.1 Students

Students can recognise their preferred learning style based on their cognitive style characteristics. By knowing this, their motivation will increase during the learning process. Other than that, the students will know their strengths and weaknesses. This is proved by Smith and Dalton (2005), who stated that learners who understand their own style would learn more effectively. Furthermore, learners who know their own learning style or preferences will make relevant choices about what to engage with and what learning resources are likely to be attractive and useful.

1.9.2 Teachers

In responding to such individual differences among students, teachers should use alternative and creative teaching techniques in order to increase students' motivation and grab their attention. Perhaps, this research will help teachers by giving them ideas to plan a creative teaching method based on their students' cognitive style. Otherwise, teachers can also design their teaching activities and materials according to students' preferences.

1.9.3 The Government

The information gathered from this study could help the Ministry in developing a new curriculum. It is hoped that the government will change to a teaching system or curriculum that emphasises the individual differences among students, so that students would be able to learn effectively. This research can also provide a helpful framework as a guideline to integrate learning styles in teaching and learning modules, especially in the subject of Chemistry. This is because the importance of Chemistry is becoming more apparent with a growing awareness of such areas as Environmental Chemistry, Nanotechnology, Food Analysis, Pest Control, Cosmetics, Medicine and Forensic Science (Cittleborough, 2004).

1.9.4 Parents

This research will help parents to recognise their children's preferences and cognitive styles as well and it is important for every parent to know what their children's learning preferences are. When parents understand which learning styles their children have, they are able to connect with their children on a deeper and more meaningful level and they will more quickly be able to teach them effectively at home.

1.10 Scope and research delimitation

This research is focussed on Form 4 students who are learning the chemical bond subtopic, based on the Integrated Curriculum for Secondary School (KBSM). The students are selected from those who are studying Chemistry in a secondary school in Johor Bahru. The research is to investigate the individuals' differences, with attention to the cognitive styles, proposed by Witkin *et al.* (1971), of Field Independence (FI) and Field Dependence (FD). In this research, attention was focused on these two types of cognitive style because they are dominant over the other cognitive styles in the literature (Danili and Reid, 2006) and are also one of the numerous factors studied in the research of learning through hypermedia systems (Kim, 2001). The students' cognitive styles will be determined using the Group Embedded Figures Test (GEFT) devised by Witkin *et al.* (1971). Furthermore, for interaction purposes, this study implements five learner-centred interaction types, which are the Learner-interface interaction, the Learner-self interaction, the Learner-content interaction, the Learner-instructor interaction and the Learner-learner interaction (Chou *et al*., 2010).

1.11 Operational Definition

There are several terminologies frequently used in this research, which are:-

1.11.1 Personalized learning environment (PLE)

According to Schaffert and Hilzensauer (2008), PLE is the sum of all the tools used (e-mail, browser, websites and applications). It is a technological realisation, where social software applications and web services are combined, for example, as a ‘mash-up’ in a single portal for the purpose of learning. Contrary to conventional instruction, in PLE the materials and learning sequence are dependent on the learner's characteristics, such as learning styles, skills, interests etc. (Sampson, Karagiannidis and Kinshuk, 2002). Riecken (2000) stated that personalization helps teachers to build a meaningful one-to-one relationship with students by understanding their needs and helps students to reach a goal, because their individual needs are fully addressed in a given context. However, in this study, the personalization term refers to the personalized learning materials that are designed and developed by considering students’ cognitive style characteristics (FD and FI). By giving students the learning materials that were designed based on their characteristics, it is hope that it will contribute to their scientific mental model development.

1.11.2 Cognitive styles

There are many cognitive style dimensions, such as field dependent vs. field independent, analytic vs. holistic and convergent vs. divergent. However, this study is focused on field dependent (FD) and field independent (FI), as proposed by Witkin and his friends in 1971. A widely cited definition, based on Witkin *et al.* (1971), defined cognitive style as the characteristic self-consistent modes of functioning that individuals show in their perceptual and intellectual activities. Alternatively, according to Lee (2007), cognitive style is an individual's preferred and habitual mode of perception, imagery, organisation and elaboration during knowledge acquisition or the problem solving process.

According to Riding and Cheema (1991), an FI person is one that has less difficulty in separating the most essential information from its context and is more likely to be influenced by internal than external cues and to be selective in their information input. By contrast, an FD person has difficulty in separating incoming information from its contextual surrounding and is more likely to be influenced by external cues and to be non-selective in their information uptake.

1.11.3 Mental Model

The mental model describes a cognitive mechanism for representing and making inferences about a system or a problem, which the user builds as he or she interacts with and learns about the system (Borgman, 1986). In addition, Gilbert (2005) stated that the mental model is an abstract concept that cannot directly be observed. Furthermore, mental models are purely abstract descriptions of memory; they are dynamic representations that change over time. However, referring to the context of Chemistry, the mental model is a personal representation of the microscopic level of matter (Cittleborough, 2004). In this study, this term is based on mental activities in the students' minds to describe the chemical concept involved at macroscopic, microscopic and symbolic level.

1.11.4 Achievement

According to the *Oxford Dictionary* 4th edition, achievement is referred to as something accomplished, especially by superior ability, special effort, great courage etc. In this area of study, achievement refers to the improvement of students' knowledge after the learning process had occurred.

1.11.5 Representation

As stated by Chittleborough (2004), representation means something that represents another thing. Representations come in a huge variety of forms and usually help the learner to construct a personal mental model.

1.11.6 Interaction

The classic definition of interaction by Moore (1989) is when a sender and a receiver connect in three types of interaction: learner-content, learner-instructor and learner–learner. Muirhead and Juwah (2004) described interaction as a dialogue, or discourse, or event between two or more participants and objects, which occurs synchronously and/or asynchronously, mediated by response or feedback and interfaced by technology. In this present research, the students' interaction with their peers, teachers, content, interface and, also, with themselves are obtained upon the implementation of the website using the data logging file, which is based on the interaction framework proposed by Chou *et al.* (2010).

1.12 Summary

This chapter has discussed how education emphasises the issue of technology and then moves from ICT to online learning and, finally, the rise of the personalized learning concept. This issue comes to mind when the needs of individual differences amongst students should be taken into account in the process of teaching and learning. In addition, studies showed that individual differences have a significant relationship with students' achievements. Hence, educators need to develop an educational environment that will appeal to the individual differences among students. Perhaps, the PLE has the potential to provide a new environment that allows students to explore learning in their context and the experiences will enrich their process in gaining new knowledge.

REFERENCES

Abdoolatiff S. and Narod F. B. (2009). Investigating the Effectiveness of Computer Simulations in the Teaching of “Atomic Structure and Bonding” in M. Gupta-Bhowon *et al.* (eds.). *Chemistry Education in the ICT Age*, 85 - 100 Springer Science + Business Media B.V

Abdul Ghani N., Hamim N. and Ishak N. (2007). *Web-Based Learning In Science Education : Overview and Implementation For Primary School in Malaysia*, International Conference on Education Universiti Brunei Darussalam. 21 – 24 May 2007, Bandar Seri Begawan

Abraham, M. R., Grzybowski, E. B., Renner, J. W. and Marek, E. A., (1992). Understandings and Misunderstandings of Eight Graders of Five Chemistry Concepts Found in Chemistry Textbooks, *Journal of Research in Science Teaching,* 29(2). 105–120.

Abraham, M. R., Williamson, V. M. and Westbrook, S. L., (1994). A Cross-Age Study of the Understanding Five Concepts. *Journal of Research in Science Teaching,* 31(2). 147–165.

Abu Hassan Z., Schattner P. And Mazza D. (2006). Doing a pilot study: why is it essential? *Malaysian Family Physician*. 1 (2 and 3)

Akcay, H., Durmaz, A., Tuysuz, C., and Feyzioglu, B. (2006). Effects of Computer Based Learning on Students’Attitudes and Achievements towards Analytical Chemistry. *The Turkish Online Journal of Educational Technology*, **5**(1), Article 6.

Aksela, M. and Lundell, J. (2008). Computer-based molecular modeling: Finnish school teachers experiences and views. *Chemistry Education Research and Practice,* 9, 301-308.

Alessi S. M. and Trollip S. R. (2001).*Multimedia for Learning*. MA : Allyn and Bacon

Alexander, B. (2009). *7 Things You Should Know About Personal Learning Environments. Educase learning Intuitive*. Retrieved 2 Feb 2010 from, www.educase.edu/eli

Allen, E. and Seaman, J. (2006). Making the Grade: Online Education in the United States, Needham, The Sloan Consortium and Babson Survey Research.

Allen A. and Seaman J. (2010). Learning on Demand Online Education in the United States, 2009, US : Babson Survey Research Group

Alonso F., López G., Manrique D.and M Viñes J. (2005). An instructional model for web-based e-learning education with a blended learning process approach. *British Journal of Educational Technology.* 36 (2), 217–235

Altun, A., and Cakan, M. (2006). Undergraduate Students' Academic Achievement, Field Dependent/Independent Cognitive Styles and Attitude toward Computers. *Educational Technology and Society*, 9 (1). 289-297.

Attwell, G. (2007). *Personal learning environments - the future of eLearning?* Retrieved 23 April 2010, from http://www.elearningpapers.eu/index.php?page=docandvol=2anddoc_id=8553anddoclng

Alomyan H. (2004). Individual Differences: Implications for Web-based Learning Design. *International Education Journal*, 4(4)

Alya Hanna Mahmud Patih. (2004). *Tahap Kefahaman Pelajar Tingkatan Empat Aliran Sains Mengenai Tajuk Ikatan Kimia*. Thesis Universiti Teknologi Malaysia.

Ally M. (2004) Foundations of Educational Theory for Online Learning. In Terry Anderson. *The Theory and Practice of Online Learning*. AU Press: Athabasca University . pp 15-44.

Anderson, T., and Elloumi, F. (eds.). (2004). *Theory and Practice of Online Learning*. Athabasca University, Retrieved October, 29, 2009 from http://cde.athabascau.ca/online_book/pdf/TPOL_book.pdf

Andris, J.F., and Stueber, A.M. (1994). Studying student navigational patterns in a hypermedia geology lab simulation and their relationship to learning style. *17th Annual Conference of the Eastern Educational Research Association*, Sarasota, FL.

Angeli, C., and Valanides, N. (2004). Examining the effects of text-only and text-and-visual instructional materials on the achievement of field-dependent and field-independent learners during problem-solving with modeling software. *ETR&D*, 52(4), 23-26

Anido, L. Liamas, M. and Fren Andez, M. J. (2001). Internet-based learning by doing. *IEEE Trans. Educ.* CD-ROM Directory 17.

Ardac, D., and Akaygun, S. (2004). Effectiveness of multimedia-based instruction that emphasizes molecular representations on students' understanding of chemical change. *Journal of Research in Science Teaching, 41*(4). 317-337.

Ary, D., Jacobs, L. C. and Razavieh, A. (1990). *Introduction to Research in Education*. 4th ed. Orlando, Florida: Holt, Rinehart and Winston, Inc.

Artwater dan Alick (1990). "Proactive Inhibition and Associative Facilitation as Affected by Degree of Prior Learning." *Journal of Experimental Psychology*. 46. 400-404.

Attwell G. (2007). Personal Learning Environments Thefuture of eLearning? *eLearning Papers*, 2(1). Retrieved Sept 2, 2010 from, http://www.elearningeuropa.info/files/media/media11561.pdf

Attwell, G. (2006). *The Wales-Wide Web*. Retrieved Sept 2, 2010 from,

http://www.knownet.com/writing/weblogs/Graham_Attwell/entries/652181936

Aviram A, Ronen Y, Somekh S, Winer A, and Sarid A. (2008). Self- Regulated Personalized Learning (SRPL): Developing iClass's pedagogical model. eLearn. 9, 1-17.

Ayersman, D. (1993). An overview of the research on learning styles and hypermedia environments. *1993 Annual Convention of the Eastern Educational Research Association*, Clearwater.

Ayersman D.J., and Minden A. (1995). Individual differences, computers and instruction. *Computers in human behaviour,* 11(3-4). 371-390.

Azizi Yahaya, Shahrin Hashim, Jamaludin Ramli, Yusof Boon, Abdul Rahim Hamdan. (2007) *Menguasai Penyelidikan Dalam Pendidikan: Teori, Analisa and Interpretasi Data*. Batu Caves : PTS Professional Publishing Sdn Bhd

Bailey, P.D. and Garratt, J. (2002) Chemical Education: Theory and Practice. *University Chemistry Education*, 6, 39-57.

Barnea, N., and Dori, Y.J. (2000). Computerized molecular modeling: The new technology for enhance model perception among chemistry educators and learners. *Chemistry Education: Research and Practice in Europe*, 1, 109–120.

Barker, V. (2000). Students' reasoning about basic chemical thermodynamics and chemical bonding: What changes occur during a context-based post-16 chemistry course? *International Journal of Science Education* 22, 1171–1200.

Barker, V. (1995) *A longitudinal study of 16-18 year olds' understanding of basic chemical ideas* unpublished D.Phil. thesis, Department of Educational Studies, University of York

Barton R. (2004). *Teaching Secondary Science with ICT*. Buckingham: Open University Press

Bassey S. W., Umoren G., and Udida L. A. (2007). *Cognitive Styles, Secondary school Students' Attitude and Academic Performance in Chemistry in Akwa Ibom State-Nigeria*. Homi Bhabha Centre for Science Education, Mumbai. February 12-15 2007.

Bayrak, B. (2007). To Compare The Effects Of Computer Based Learning And The Laboratory Based Learning On Students' Achievement Regarding Electric Circuits, *The Turkish Online Journal of Educational Technology.* 6(1)

Bell, J. (1993). *Doing Your Research Project : A Guide for First-Time Researchers in Education and Social Science*. 2nd ed. Buckingham: Open University Press.

Bentley, T. and R. Miller (2004). Personalisation; Creating the Ingredients for Systematic and Society-wide Change. *Personalised Learning Conference*, London, 17-18 May

Ben-Zvi, R., Eylon, B., and Silberstein, J. (1986). Is an atom of copper malleable? *Journal of Chemical Education,* 63, 64 - 66.

Best, J. W. and Kahn, J. V. (1998). *Research in Education*. 8th ed. Needham Heights, MA: Allyn and Bacon.

Biggs, J. B., and Telfer, R. (1987). *The process of learning* (2nd ed.). Sydney, Australia: Prentice Hall.

Blickle, G. (1996). Personality traits, learning strategies, and performance. *European Journal of Personality,* 10, 337-352.

Bloomfield J., Roberts J., and While A. (2010). The effect of computer-assisted learning versus conventional teaching methods on the acquisition and retention of handwashing theory and skills in pre-qualification nursing students: A randomised controlled trial. *International Journal of Nursing Studies*. 47(3) 287-294.

Bodner, G. M., and Domin, D. S. (2000). Mental models: The role of representations in problem solving in chemistry. *Chemistry Education*, 4(1), 24-30.

Boo, K. H. (1998). Students' understanding of chemical bond and the energetic of chemical reactions. Journal of Research in Science Teaching., 35(5). 569-581

Borgman C. L., (1986). The user's mental model of an information retrieval system: an experiment on a prototype online catalog. *International Journal of Man-Machine Studies* . 24(1). 47-64

BouJaoude S. and Attieh M. (2008). The Effect of Using Concept Maps as Study Tools on Achievement in Chemistry *Eurasia Journal of Mathematics, Science and Technology Education,* 2008, 4(3). 233-246

Brewer, J. and Hunter, A. (1989). *Multimethod Research : A Synthesis of Styles*. Newbury Park, California: SAGE Publications, Inc.

Bradley, J. D. and Brand, M., (1985). Stamping Out Misconceptions, *Journal of Chemical Education,* 62(4). 318.

Brickell, G. (1993). Navigation and learning style. *Australian Journal of Educational Technology,* 9(2). 103-114

Broeck, H. V. D., Vanderheyden, K., and Cools, A. (2003). Individual differences in cognitive styles: development, validation, and cross-validation of the cognitive style inventory. *Vlerick Leuven Gent Working Paper Series,* 27.

Brousseau N. (2005). High School Students Problems Learning The Concept of Mole : A Study to Eventually Get it Right? Paper presented at the 18th biennial CheEd Conference, The University of British Columbia, Vancauver BC, Canada July 31-Aug 4

Burns, R. B. (2000). *Introduction to Research Methods*. 4th ed. Frenchs Forest: Pearson Education Australia Pty Limited.Bunce D. M. and Gabel D., (2002). Differential effects in the achievement of males and females of teaching the particulate nature of chemistry, Journal Reserach in Science Teaching. 39, 911-972.

Bunce D. M., (2001). Does Piaget Still Have Anything to Say to Chemists? *Journal of Chemistry Education*, 78 (8), 1107

Brusilovsky P. (2001). Adaptive hypermedia *User modeling and user-adapted interaction,* 11, 111–127.

Bryman A. (2001). *Social research method*. New York: oxford University Press Inc

Butts, B., and Smith, R. (1987). HSC chemistry students' understanding of the structure and properties of molecular and ionic compounds. *Research in Science Education* 17: 192–201.

Cairncross, S. and Mannon, M. (2001). Interactive Multimedia and Learning: Realizing the Benefits. *Innovations in Education and Teaching International*, 38(2), 156-164(9)

Cakan, M. (2003). Psychometric data on the Group Embedded Figures Test for Turkish undergraduate students. *Perceptual and Motor Skills,* 96, 993-1004.

Cakan, M. (2000). *Interaction between cognitive styles and assessment approaches.* Unpublished doctoral dissertation, Louisiana State University, USA. Baton Rouge.

Calcaterra A. , Antonietti A., Underwood J. (2005). Cognitive style, hypermedia navigation and learning. *Computers and Education,* 44, 441–457

Calisir F. And Gurel, Z. (2003). Influence of text structure and prior knowledge of the learner on reading comprehension, browsing and perceived control. *Computers in Human Behavior*. 192(2). 135-145

Campbell, D. T. and Stanley, J. C. (1963). *Experimental and Quasi-Experimental Designs for Research*. Chicago: Rand McNally.

Capuano N, Gaeta M, Orciuoli F, Ritrovato P (2009). On-Demand Construction of Personalized Learning Experiences Using Semantic Web and Web 2.0 Techniques. University of Salerno, Fisciano (SA), Italy.

Carver, C. A., Howard R. A. and Lavelle E. (1996). Enhancing student learning by incorporating student learning styles into adaptive hypermedia. *Proceedings of EDMEDIA '96 - World Conference on EducationalMultimedia and Hypermedia*,
Boston, MA, pp. 118-123.

Chakraborty I., Hu P., and Cui D. (2005). Examining Effects of Cognitive Style on Technology Acceptance Decisions. *PACIS Conference 2005.*

Chakraborty, I., Hu, P. J.-H., and Cui, D. (2008). Examining the effects of cognitive style in individuals' technology use decision making. *Journal of Decision Support Systems,* 45(2). 228-241

Chandrasegaran, A. L., Treagust, D. F., and Mocerino, M. (2008). An evaluation of a teaching intervention to promote students' ability to use multiple levels of representation when describing and explaining chemical reactions. *Research in Science Education, 38*(2). 237-248.

Chang, C.T. (1995). *Astudy of hypertext document structure and individual differences: Effects on learning performance*. Unpublished doctoral dissertation, University of Illinois, Urbana-Champaign.

Chang C.Y. (2001). Comparing the Impacts of a Problem-Based Computer-Assisted Instruction and the Direct-Interactive Teaching Method on Student Science Achievement. *Journal of Science Education and Technology*. 10(2)

Chatti, M. A., Agustiawan, M. R., Jarke, M., and Specht, M. (2010). Toward a Personal Learning Environment Framework. International Journal of Virtual and Personal Learning Environments, 1(4), 66-85.

Chang, V. and Fisher, D. (2003). The validation and application of a new learning environment instrument for online learning in higher education. In Khine M. S. and Fisher D. (Eds.). *Technology-rich learning environments: A future perspective* (pp. 1-20). Singapore: World Scientific

Chen, S.Y., Ford, N.J. (2000). Individual differences, hypermedia navigation and learning: An empirical study. *Journal of Educational Multimedia and Hypermedia*. 19 (4), 281–312.

Chen, S. (2002). A cognitive model of non-linear learning in hypermedia programs. *British Journal of Educational Technology,* 33(4). 449-460.

Chen S. Y., and Macredie, R. D. (2002). Cognitive style and hypermedia navigation: development of a learning model. *Journal of the American Society for Information Science and Technology.* 53(1). 3-15

Chen, S., and Macredie, R. D. (2004). Cognitive modeling of student learning in web-based instructional programs. *International Journal of Human Computer Interaction*, 17, 375–402.

Chen. Y. S. and Paul. R. J. (2003) Individual differences in web-based instruction-an overview. *British Journal of Educational Technology.* 34(4). 385-392

Chen L. H. (2010). Web-based learning programs: Use by learners with various cognitive styles. *Computers and Education*. 54, 1028-1035

Chen, N. S., Wei, C. W., Wu, K. T., and Uden, L. (2008). Effects of high level prompts and peer assessment on online learners' reflection levels. *Computers and Education*, 52(2), 283– 291

Chou C. Peng H.and Chang C. (2010). The technical framework of interactive function for course-management system: Students' perceptions, uses, and evaluations. *Journal of Computer and Education* 55, 1004-1017

Chou C. (2003). Interactivity and interactive functions in web-basedlearning systems: a technical framework for designers. *British Journal of Educational Technology 34(3).* 265–279

Chou, H. W. (2001). Influences of cognitive style and training method on training effectiveness. *Computers and Education*, 37, 11–25.

Chittleborough, G. D., and Treagust, D. F. (2008). Correct interpretation of chemical diagrams requires transforming from one level of representation to another. *Research in Science Education*, *38*(4). 463–482.

Chittleborough, G. D., and Treagust, D. F. (2007). The modelling ability of non-major chemistry students and their understanding of the sub-microscopic level. *Chemistry Education Research and Practice*, 8(3). 274–292.

Cittleborough, G. D. (2004). *The role of teaching model and chemical representations in developing students' mental models of chemical phenomena*. Australia: Curtin University of Technology.

Chittleborough, G., and Treagust, D. F. (2007). The modelling ability of non-major chemistry students and their understanding of the sub-microscopic level. *Chemistry Education Research and Practice,* 8(3). 274-292.

Chittleborough, G. D., Treagust, D. F., Mamiala, T. L., and Mocerino, M. (2005). Students' perceptions of the role of models in the process of science and in the process of learning. *Research in Science and Technological Education, 23*(2). 195-212.

Chittleborough, G. D., Treagust, D. F., and Mocerino, M. (2002) Constraints to the development of first year university chemistry students' mental models of chemical phenomena. Presented at the 11th Annual Teaching and Learning Forum for Western Australian Universities, Edith Cowan University, Australia, February 2002

Clark D. (2004). Hands-on investigation in Internet environments: Teaching thermal equilibrium. In: M.C. Linn, E.A. Davis, and P. Bell (Eds.). *Internet environments for science education.* Mahwah, NJ: Erlbaum.

Clarke, J. (2003). Personalized learning and personalized teaching. In J. DiMartino, J. Clarke, and D. Wolk (Eds.), Personalized learning: Preparing high school students to create their futures. Lanham, MD: Scarecrow.

Clements K. and Douglas C. (2008) *Personalized Learning and Innovation in Education*. Desire2Learn Incorporated. Retrieved Sept 4, 2010 http://www.desire2learn.com/media/docs/wp/Desire2Learn_whitepaper_personalizedLearning.pdf.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Second Edition. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Cohen L., Manion L. and Morrison K., (2000), Research methods in education (5th ed.), London: Routledge Falmer

Cohen L., Manion L. Morrison K. (2007). *Research method in education.* Milton Park.: Routledge 2 Park square

Coll, R.K. and Treagust, D.F. (2000) Learners' Mental Models of Metallic Bonding: a cross-age study, paper presented at the 31st Annual Conference of the Australasian Science Education Research Association, Fremantle, Western Australia.

Coll, R. K., and Taylor,N. (2001). Alternative conceptions of chemical bonding held by upper secondary and tertiary students. *Research in Science and Technological Education* 19, 171–191.

Coll, R. K. and Treagust, D. F., (2001). Learners' Use Of Analogy And Alternative Conceptions For Chemical Bonding, *Australian Science Teachers Journal,* 48(1). 24–32.

Coll R. K. and Treagust D. F (2001). Learner's mental model of chemical bonding. *Research in Science Education*. 31, 357-382

Coll, R. K. and Taylor, N., (2002). Mental Models In Chemistry: Senior Chemistry Students' Mental Models Of Chemical Bonding, *Chemistry Education: Research and Practice in Europe,* 3(2). 175–184.

Coll, R. K. and Treagust, D. F., (2003). Investigation of Secondary School, Undergraduate and Graduate Learners' Mental Models of Ionic Bonding. *Journal of Research in Science Teaching,* 40(5). 464–486.

Coll, R.K. (2006) The role of models, mental models and analogies in chemistry teaching. In P. Aubusson, A. Harrison and S.M. Ritchie (Eds.). *Metaphor and analogy in science education*. Dordrecht: Kluwer

Coll R. K., Lay M. C. and Zegwaard K. E. (2002): Enhancing access to experiential learning in a science and technology degree programme, Journal of Vocational Education and Training, 54:2, 197-218

Coll, R. K. (2008). Chemistry Learners' Preferred Mental Models for Chemical Bonding. *Journal of Turkish science Education*. 5(1)

Comeaux P. (2005). *Assessing Online Learning.* Bolton, MA : Anker Pub. Company Inc.,

Cook D. A. and Dupras D. M. (2004). A practical guide to developing effective web-based learning. *Journal of General Internal Medicine,* 19(6). 698-707

Copolo, C. E., and Hounshell, P. B. (1995). Using three-dimensional models to teach molecular structures in high school chemistry. *Journal of Science Education and Technology, 4*(4). 295-305.

Corno L. and Snow E. (1986). Adapting Teaching to Individual Differences among Learners. In Wittrock M. (ed.) Handbook of Research on Teaching, New-York: Macmillan, 605-29.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative and mixed methods approaches* (2^{nd} ed.). CA: Thousand Oaks: Sage.

Creswell, J. W. (1994). *Research Design : Qualitative and Quantitative Approaches*. Thousand Oaks, California: SAGE Publications, Inc.

Creswell, J. W. (2002). *Educational research: Planning, conducting and evaluating quantitative and Qualitative Research.* New Jersy: Pearson Education, Inc

Creswell, J. W. (2009) *Research design: Qualitative, quantitative, and mixed method approaches*. Thousand Oaks: Sage Publications.

Cristea A. (2004). Authoring of adaptive and adaptable educational hypermedia: Where are we now and where are we going? *IASTED International Conference in Web-Based Education*, February 2004.

Curry, L. (1983). *Learning Styles in Continuing Medical Education*, Canadian Medical Association, Ottowa.

Dag F. and Gecer A. (2009) Relations between online learning and learning styles. *Procedia Social and Behavioral Sciences*, 1, 862–871

Dahsah C. and Coll R. K. (2007): Thai Grade 10 and 11 students' conceptual understanding and ability to solve stoichiometry problems, Research in Science and Technological Education, 25(2) , 227-241

Daniels, H. L., and Moore, D. M. (2000). Interaction of cognitive style and learner control in a hypermedia environment. *International Journal of Instructional Media*, 27, 369–384.

Danili E. and Reid N. (2006). Cognitive factors that can potentially affect pupils' test performance. *Chemistry education research and practice*. 7(2). 64-83

Danili E. and Reid N., (2004). Some strategies to improve performance in school chemistry, based on two cognitive factors. *Res. Science Technology Education,* 22, 201-223

Davidowitz B.and Chittleborough G. (2009) *Linking the Macroscopic and Sub-microscopic Levels: Diagrams* Gilbert J.K. and Treagust D. (eds.). *Multiple Representations in Chemical Education,*Models and Modeling in Science Education 4, Springer Science+Business Media 169-191

Davies, T., Lavin, A., and Korte, L. (2008). Student perceptions of how technology impacts quality of instruction and learning. *Journal of Instructional Pedagogies*, 1, 2-16.

Demircioglu G,. Ayas A., Demircioglu H., (2005). Conceptual change achieved through a new teaching program on acids and bases. *Chemistry Education Research and Practice*, 691). 36 -51

Dennen, V. P., and Paulus, T. M. (2005). Researching "Collaborative Knowledge Building" in Formal Distance Learning Environments . Proceedings of 2005 conference on Computer support for collaborative learning Taipei, Taiwan: International Society of the Learning Sciences. (pp. 96-104).

De Posada, J. M. (1999). The representation of metallic bonding in high school science textbooks during three decades: science educational reforms and substantive changes of tendencies. *Science education,* 83, 423-447

De Raad, B. (1996.) Personality traits in learning and education. *European Journal of Personality*, 10, 185-200.

De Vaus, D. A. (2001) *Research design in social research*. London: Sage Publications.

De Vita, G. (2001). Learning styles, culture and inclusive instruction in the multicultural classroom: A business and management perspective. *Innovations in Education and Teaching International*, *38*(2), 165–174.

De Vos, A.S., Strydom, H., Fouche, C.B., and Delport, C.S.L. (2002). *Research at Grass Roots for the Social Sciences and Human Service Professions.* Pretoria :J.L. Van Schaik Publishers.

Devetak, I. (2005). *Explaining the latent structure of understanding submicropresentations in science.* Unpublished dissertation, University of Ljubljana, Slovenia.

Devetak, I., Urbancic, M., Wissiak Grm, K. S., Krnel, D., and Glažar, S. A. (2004). Submicroscopic representations as a tool for evaluating students' chemical conceptions. *Acta Chimica Slovenica, 51*, 799-814.

Devetak I., Vogrinc J. and Glažar S. A., (2009). Assessing 16-year-old students' understanding of aqueous solution at submicroscopic level. *Research in Science Education ,* 39, 157-179.

Dhindsa H.S. and Treagust D. F. (2009). Conceptual Understanding of Bruneian Tertiary Students: Chemical Bonding and Structure. *Brunei International Journal of Science and Math. Edu*, 1(1), 33-51

Dietinger, T. (2003). *Aspects of e-learning environments*. Unpublished doctoral dissertation, Graz University of Technology, Austria.

Donmez O., Simsek O., Arikan Y. D, (2010). How can we make use of learner interaction in online learning environments? Procedia Social and Behavioral Sciences, 9, 783–787

Dori, Y., and Barak, M. (2000). Computerized Molecular Modeling: Enhancing Meaningful Chemistry Learning. In B. Fishman and S. O'Connor-Divelbiss (Eds.). Proceedings of the Fourth International Conference of theLearning Sciences (pp. 185-192). Mahwah, NJ: Erlbaum.

Dori, Y. J., and Hameiri, M. (2003). Multidimensional analysis system for quantitative chemistry problems: Symbol, macro, micro, and process aspects. *Journal of Research in Science Teaching,* 40(3). 278-302.

Downes, S. (2005). E-learning 2.0. *ELearn*, Retrieved 8 May 2010 from, http://www.elearnmag.org/subpage.cfm?article=29-1andsection=articles

Downes, S. (2006). *Learning Networks and Connective Knowledge*. Discussion Paper. Instructional Technology Forum. Retrieved Okt 1, 2010 from http://it.coe.uga.edu/itforum/paper92/paper92.html

Dron, J. (2007). Designing the undesignable: Social software and control. *Educational Technology and Society*, 10(3). 60-71

du Toit J. (2009). A conceptual framework of designs for urban design research. Retrieved 5 July 2010 from, http://api.ning.com/files/dOPtu7qbGChsnM--aFoeTEckKuRQs3JhqURFuQhG4xMTx1kQlsCs710HhVtIkg9wqqR9uxUbWYDXk8ajkTDZ-ObpCyVYh8EE/paper_dutoit_091120.pdf

Dwyer, F. M., and Moore, D. M. (1995). *Effect of color coding and test type (visual/ Verbal) on students identified as possessing different field dependence level*, ERIC Document No. Ed 380 078.

Ebenezer, J. V. (2001). A Hypermedia Environment To Explore And Negotiate Students' Conceptions: Animation Of The Solution Process Of Table Salt, *Journal of Science Education and Technology.* 10(1). 73–92.

Eilks I., Moellering J. and Valanides N. (2007). Seventh-grade Students' Understanding of Chemical Reactions: Reflections from an Action Research Interview Study. *Eurasia Journal of Mathematics, Science and Technology Education,* 3(4), 271-286

Erduran, S. (2003). Examining the mismatch between pupil and teacher knowledge in acid-base chemistry. *School Science Review*, 84(308). 81-87.

Erickson G. L (1979). Children's conceptions of heat and temperature. *Science education*. 63(2). 221-230

Falvo, D. (2008). Animations and simulations for teaching and learning molecular chemistry. *International Journal of Technology in Teaching and Learning, 4*(1)*,* 68–77.

Fang J. P., and Macredie R. D. (2006). Gender differences and Hypermedia navigation : principles for Adaptive Hypermedia Learning Systems. In Magoulas G. D. and Chen, S.Y. (2006). *Advances in Web-Based Education ; Personalized Learning Environment*. Idea Group Publishing. pp 1-20

Farida I., Liliasari, Widyantoro D. H. and Sopandi W. (2010). *Representational Competence's Profile of Pre-Service Chemistry Teachers in Chemical Problem Solving* .Paper presented at 4th International Seminar of Science Education, Bandung. 30 October 2010

Fatt, J.P.T., (2000). Understanding the learning styles of students: implications for educators, *International Journal of Sociology and Social Policy,* 20, 31-45.

Federico P. (2000). Learning styles and student attitudes toward various aspects of network-based instruction. *Computers in Human Behavior* 16, 359–379.

Felder, R. (1998). Matters of style. Retrieved Sept 5, 2010 at: www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/LS-Prism.

Felix U. (2001). A multivariate analysis of students' experience of web based learning. *Australian Journal of Educational Technology.* 17(1). 21–36.

Fitzgerald, G. and Semrau, L. (1998). The effects of learner differences on usage patterns and learning outcomes with hypermedia case studies. *Journal of Educational Multimedia and Hypermedia,* 7(4), 309–331.

Fisher, K. (2010). *Technology-enabled active learning environments: an appraisal.* CELE Exchange 2010/7, OECD Publication. Retrieved Sept 5, 2010 from Publication http://www.oecd.org/dataoecd/33/38/45565315.pdf

Fonseca J. R. S. (2007). On The Contribution of Using Computers In The Classroom In Teaching/Learning Statistics. *In 37th ASEE/IEEE Frontiers in Education Conference*, Milwaukee, October 2007.

Ford, N. and Chen, S.Y. (2000). Individual differences, hypermedia navigation and learning: An empirical study. *Journal of Educational Multimedia and Hypermedia*, 9(4). 281–312.

Foster J. and Lin A. (2003). Individual differences in learning entrepreneurship and their implications for web-based instruction in e-business and e-commerce. *British Journal of Educational Technology,* 34(4). 455–465

Franco, C., and Colinvaux, D. (2000). Grasping mental models. In J. K. Gilbert and C. J. Boulter (Eds.). *Developing models in science education* (pp. 93-118). Dordrecht: Kluwer

Frailich M., Kesner M., Hofstein A. 2009 . Enhancing Students' Understanding of the Concept of Chemical Bonding by Using Activities Provided on an Interactive Website. *Journal of Research in science teaching.* 46(30). 289–310

Fraenkel, J. R. and Wallen, N. E. (1996). *How to Design and Evaluate Research in Education*. 3rd. ed. USA: McGraw-Hill, Inc.

Falvo D. (2008). Animations and simulations for teaching and learning molecular chemistry. International Journal Technology Teaching Learning, 4(1), 68-77.

Gabel D. L. (1992). Modeling With Magnets – A Unified Approach To Chemistry Problem Solving. *The Science Teacher*, 58–63.

Gabel, D. L. (Ed.). (1994). *Handbook of research on science teaching and learning*. New York: MacMillan.

Gabel, D. L. (1999). Improving teaching and learning through chemistry education research: A look to the future. *Journal of Chemical Education, 76*(4). 548-554.

Gabel, D. (1996). The complexity of chemistry: Research for teaching in the 21st century. *14th International Conference on Chemical Education*. Brisbane, Australia. July

Gabel, D. L. (1998). The complexity of chemistry and its implications for teaching. In Fraser B. J. and Tobin K. G. (Eds.). *International handbook of science education* (Vol. 1, pp. 223–248). London: Kluwer.

Gagne R. M., Wager W. W., Golas K. C.,and Keller J. M. (2005). *Principle of Instructional Design*. 5th ed. Belmont: Wadsworth Cengage Learning

Garger, S., and Guild, P. (1987). Learning styles: The crucial differences. *Curriculum Review*, 23, 9-12.

Garnett, P., Garnett, P. and Hackling, M. (1995). Students' alternative conceptions in chemistry: A review of research and implications for teaching and learning. *Studies in Science Education,* 25, 69-95.

Garnett, P., Oliver, R. and Hackling, M. (1998). Designing interactive multimedia materials to support concept development in beginning chemistry classes. In Global Education On the Net: Proceedings of the 6th International Conference on Computers in Education Volume 1, Tak-Wai Chan, Allan Collins and Jianxiang Lin (eds). China Higher Education Press=Springer Verlag, Beijing=Heidelberg, 297-304.

Garton, B.L., Spain, J.N., Lamberson, W.R. dan Spiers, D.E. (1999). Learning Styles, Teaching Performance, and Student Achievement: A relational Study. *Journal of Agricultural Education.* 40(3).

Georgiadou A. and Tsaparlis G., (2000). Chemistry teaching in lower secondary school with methods based on: a) psychological theories; b) the macro, representational, and submicro levels of chemistry. *Chemical Education Research and Practice*, 1, 217-226.

Gerald, K. (2002). *The Relationship of Attitudes Toward Science, Cognitive Styles and Self Concept to Achievement At The Secondary School Level.* University of Florida : Masters dissertation

Ghinter, D. and Liu Y. (1999) Cognitive Styles and distance education. *The Journal of Distance Learning Administration*, 2(3), Article 005.

Gilbert J.K. and Treagust D.F. Hodson, D. (1990). A critical look at practical work in school science. *School Science Review,*71(256). 33–40.

Gilbert, J. K., and Rutherford, M. (1998). Models in explanations Part 1: Horses for courses? *International Journal of Science Education*, 20(1). 83–97.

Gilbert, J. K., and Rutherford, M. (1998). Models in explanations Part 2: Whose voice?Whose ears? *International Journal of Science Education*, 20(2). 187–203.

Gilbert, J. E. and Han C. Y. (1999). Arthur: Adapting Instruction to Accommodate Learning Style. *Proceedings of WebNet'99, World Conference of the WWW and Internet, Honolulu,* HI, 433-438.

Gilbert J.E, and Han C.Y. (2002). Arthur: A Personalized Instructional System. J. Comput. Higher Educ., 14(1): 113-129

Gilbert, J. K. (2005). Models and Modeling in Science Education. Teoksessa: Gilbert, J. K. (Toim.). *Visualization in science education*, (1, 1 – 7). Dordrecht: Kluwer.

Gilbert, J. K., Boulter, C. J., and Rutherford, M. (2000). Explanations with Models in Science Education Teoksessa: J. K. Gilbert and C. J. Boulter (Toim.). *Developing Models in Science Education*, (193- 208). Dordrecht: Kluwer

Gilbert J. K and Treagust D. F. (2009). Introduction: Macro, Submicro and Symbolic Representations and the Relationship Between Them: Key Models in Chemical Education in. Gilbert J.K, Treagust D.F. (eds.). *Multiple Representations in Chemical Education,* Models and Modeling in Science Education 4 Springer Science+Business Media B.V.

Gobert, J. D., and Buckley, B. C. (2000). Introduction to model-based teaching and learning in science education. *International Journal of Science Education,* 22(9). 891-894.

Golafshani N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report* 8(4), 597-607. http://www.nova.edu/ssss/QR/QR8-4/golafshani.pdf

Goh, N. K., Khoo, L. E., and Chia, L. S. (1993). Some misconceptionsin chemistry:Across-cultural comparison, and implications for teaching. *Australian Science Teachers Journal* 39, 65–68.

Graft M. (2003). Cognitive Style and Attitudes Towards Using Online Learning and Assessment Methods. *Electronic Journal of e-Learnin.* 1(1). 21-28

Gravetter, F. and Forzano, L. (2009) *Research methods for the behavioralsciences.* Wadsworth: Cengage Learning.

Green H., Facer K., Rudd, T., Dillon P. and Himphreys P. (2005). Personalisation and digital technologies. [Online]. Available: http://www.maximise-ict.co.uk/Personalisation_Report.pdf

Gu X. and Li X.(2009). A Conceptual Model of Personal Learning Environment Based On Shanghai Lifelong Learning System. *Proceedings of the 17th International Conference on Computers in Education [CDROM*]. Hong Kong: Asia-Pacific Society for Computers in Education, 885

Gustafon, K.L and Branch, R. M. (1977). Revisioning Models of Istructional Development. *Educational Technology Research Development*. 45(3). 73-89

Hafilah Othman (2008). Kefahaman pelajar tingkatan empat sekolah menengah mengenai ikatan Kimia. UTM Thesis

Harrison, A. G. and Treagust, D. F., (1996). Secondary Students' Mental Models of Atoms and Molecules: Implications for Teaching Chemistry, *Science Education,* 80(5). 509–534.

Harrison, A. G. and Treagust, D. F. (2000). Learning about atoms, molecules, and chemical bonds: A case study of multiple-model use in grade 11 chemistry. *Science Education*, 84, 352-381.

Harrison, A. G., and Treagust, D. F. (2002). The particulate nature of matter: Challenges to understanding the submicroscopic world. In J. Gilbert, K., O. de Jong, R. Justi, D. F. Treagust and H. Van Driel (Eds.). *Chemical education: Towards research-based practice* (pp. 189–212). Dordrecht: Kluwer.

Havill D. Hashim B. W. (2002). Optimizing Computer-Based Developmental Math Learning At an Arabic Women's University. *Turkish Online Journal of Educational Technology. 3(4)*

Hew, K. F., and Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, 55(3), 223-252

Hiemstra, R. (2009). Writing objectives, executive summaries, criterion referenced testing, goals for the first team meeting, and stages of team growth. Retrieved 20 Disember 2011 from http://www-distance.syr.edu/miscellaneous.html.

Hinton, M. E.,and Nahkleh, M. B. (1999). Students,, microscopic, macroscopic, and symbolic representations of chemical reactions. *Chemical Educator*, 4(4), 1-29

Hittleman, D. R. and Simon, A. J. (1997). *Interpreting Educational Research : An Introduction for Consumers of Research*. 2nd ed. Upper Saddle River, New Jersey: Prentice-Hall, Inc.

Hölscherl C. and Strubel G. (2000). Web search behavior of Internet experts and new users. *Computer Networks.* 33(1). 337–346.

Huang, S. L., and Yang, C. W. (2009). Designing a semantic bliki system to support different types of knowledge and adaptive learning. *Computers and Education*, 53(3), 701–712

Hunt O. (2007) A Mixed Method Design. Retrieved 28 August 2010 from http://www.articlealley.com/article_185975_22.html

Ibiş M. (1999). *The influence of Computer assisted Science Instruction on the success of the students*. Ankara: Gazi University, Institute of Educational Sciences, Unpublished Master Thesis

Inan, F. A. and Grant, M.M. (2008). Individualized web-based instructional design. In Kidd, T. T., and Song, H. (Eds). *Handbook of Research on Instructional Systems and Technology.* Harrisburg, PA: Idea Group Publishing.

Inan F. A., Flores R., Grant M. M. (2010). Perspectives on the Design and Evaluation of Adaptive Web Based Learning Environments. *Cotemporary Educational Technology*, 1(2). 148-159

Jafari, A., McGee, P., and Carmean, C. (2006). Managing courses, defining learning: What faculty, students, and administrators want. *EDUCAUSE Review*, *41*(4), 50–71.

Jonassen, D.H., Beissner, K., and Yacci, M. (1993). *Structural knowledge: Techniques for representing, conveying, and acquiring structural knowledge*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Jansoon N., Coll R.K. and Somsook E. (2009). Understanding Mental Models of Dilution in Thai Students. *International Journal of Environmental and Science Education,* 4(2). 147-168

Jick, T. D. (1979). Mixing qualitative and quantitative method. Triangulation in action. *Administrative Science Quarterly*, 24, 602-611

Johnson, S. D. and Aragon, S. A. (2003) An instructional strategy framework for online learning environments. In *Facilitating Learning in Online Environments, New Directions for Adult and Continuing Education*, S. Aragon (ed.). Jossey-Bass, San Francisco: 10, 31–44.

Johnson-Laird, P.N. (2004). The history of mental models. In: Manktelow, K., Chung, M.C. (eds.). *Psychology of Reasoning: Theoretical and Historical Perspectives*, pp. 179–212. Psychology Press, New York

Johnstone A. H. (1982). Macro and Micro Chemistry. *School Science Review*, 64, 377-379

Johnstone, A.H.(1991). Why Science is Difficult to Learn? Things are Seldom What they Seem. *Journal of Computer Assisted Learn*ing. 7, 75-83.

Johnstone, A. H. (1993). The Development of Chemistry Teaching: A Changing Response to Changing Demand. *Journal of Chemical Education, 70,* 701-705.

Johnstone A. H. (2000). Teaching chemistry : Logical or Pshycological. *Chemistry Education: Research and Practice in Europe,* 1(1). 9-15

Jolliffe, A. Ritter J. And Stevens D. (2001). *The Online Learning Handbook: Developing and Using Web-Based Learning*. Kogan Page, London, UK.

Jones, D. (2008). PLES: framing one future for lifelong learning, e-learning and universities. In D. Orr, P.A. Danaher, G. Danaher and R.E. Harreveld (Eds.). *Lifelong Learning: reflecting on successes and framing futures. Keynote and refereed papers from the 5th International Lifelong Learning Proceedings ascilite Melbourne 2008: Full paper: Jones, Vallack and Fitzgerald-Hood 454 Conference* (pp. 231-236). Rockhampton: Central Queensland University Press. http://hdl.cqu.edu.au/10018/13437

Johnson, P. (2002). Children's understanding of substances, part 2: Explaining chemical change. *International Journal of Science Education*, *24*, 1037 - 1049.

Johnson, M. And Liber, O. (2008). The personal learning environment and the human conditions: From theory to teaching practice. Interactive Learning Environments, 16(1), 3-15.

Joppe, M. (2000). *The Research Process.* Retrieved August 25, 2010, from http://www.ryerson.ca/~mjoppe/rp.htm Meor Ibrahim bin Kamaruddin (2001) *Modul Pembelajran Sains dan Matematik*. UTM Skudai Johor.

Jung, I. S. (2001). Building a theoretical framework of Web-based instruction in the context of distance education. *British Journal of Educational Technology,* 32(5).

Jung J. and Graf S. (2008). An Approach for Personalized Web-based Vocabulary Learning through Word Association Games. SAINT, pp. 325-328.

Justi, R. and Gilbert, J. (2002). Models and modelling in chemical education. In J. K. Gilbert, O. D. Jong, R. Justy, D. F., Treagust, and J. H. Van Driel (eds.). *Chemical education: Towards researchbased practice,* pp. 47-68. Dordrecht: Kluwer.

Kang S. (1999) Learning styles: Implications for ESL/EFL Instruction. English Teaching Forum. 37 (4)

Karagiannidis, C., Sampson, D. and Cardinali, F. (2001). Integrating Adaptive Educational Content into Different Courses and Curricula. *Educational Technology and Society,*4

Ke, H., Kwakkelaarb, R.,Taic, Y., and Chenc, L. (2002) Exploring behavior of e-joumal users in science and technology: Transaction log analysis of Elsevier's ScienceDirect On Site in Taiwan. *Library and Information Science Research*. 24 (3), 265-291

Keig, P.F., and Rubba, P.A. (1993). Translation of representations of the structure of matter and its relationship to reasoning, gender, spatial reasoning, and speci®c prior knowledge. *Journal of Research in Science Teaching,* 30(8). 883 - 903.

Kelly, R. M., and Jones, L., L. (2007). Exploring how different features of animations of sodium chloride dissolution affect students' explanations. *Journal of Science Education Technology*, 16, 413-429

Khalifa M. And R. Lam. (2002) Web based learning: effects on learning process and outcome. *IEEE Transactions on Education* 45pp.

Khalid, T. (2003). Pre-service high school teachers' perceptions of three environmental phenomena. *Environmental Education Research* 9, 35–50.

Khine, M. S. (1996). The interaction of cognitive styles with varying levels of feedback in multimedia presentation. *International Journal of Instructional Media*, 23, 229–237.

Khodadady E., Fatemi A. H., Etminan S. (2012). Cognitive Styles and Performance on Schema-based Cloze Multiple Choice Item Tests: A Fairness Issue. *Journal of Language Teaching and Research*, 3(4), 806-813

Killedar M. (2008). Effectiveness of learning process using "Web Technology" in distance learning system. *Turkish Online Journal of Distance Education*, 9(4).

Kim, K.S. (1997). Effects of cognitive and problem-solving styles on the information-seeking behavior on the web. Retrieved from http://www.edb.utexas.edu/mmresearch/Students97/Kim/intro.html in 9/24/03

Kim K., (2001). Implications of User Characteristics in Information Seeking on the World Wide Web. *International Journal of Human-Computer Interaction,* 13(3). 323–340

Kim, K. S. (2001). Information seeing on the Web: effects of user and task variables. *Library and Information Science Research,* 23, 233-255

Kim, I. S. (2009). The relevance of multiple intelligences to CALL instruction. The Reading Matrix, 9(1), 1–21.

Koohang, A., Riley, L., Smith, T., and Schreurs, J. (2009). E-learning and constructivism: From theory to application. *Interdisciplinary Journal of E-Learning and Learning Objects, 5*, 91-109.

Kozma, R. and Russell J. (2007). Assessing Learning from the Use of Multimedia Chemical Visualization Software. In John K. Gilbert (ed.) *Visualization in Science Education.* 299-332. Springer.

Kozma, R.B., and Russell, J. (1997). Multimedia and understanding: Expert and novice responses to different representations of chemical phenomena. *Journal of Research in Science Teaching,* 34, 949 -968.

Kozma, R. (2000). The Use of Multiuple Representations and the Social Construction of Understanding Chemistry. In M. Jacobsen and R. Kozma (Eds.), Innovations in science and mathematics education: Advanced designs for technologies of learning (pp. 11-46). Mahwah, NJ, USA: Erlbaum

Krajcik, J.S. (1991). Developing students' understanding of chemical concepts. In S.M. Glynn, R.H. Yeany, and B.K. Britton (Eds.). The psychology of learning science: International perspective on the psychological foundations of technology-based learning environments (pp. 117- 145). Hillsdale, NJ: Erlbaum.

Kumar. R. (2005). *Research methodology : a step-by-step guide for beginners.* London : Sage Publication Ltd Lancaster G. A., Dodd S., Williamson P.R., (2004). Design and analysis of pilot studies: recommendations for good practice. *Journal of Evaluation in Clinical Practice*. 10(2) 307-312

Laurillard, D. (2002). *Rethinking university teaching*: *A framework for the effective use*

of educational technology (2nd ed.). London: Routledge.

Large, J.A., Beheshti, J. and Rahman, T. (2002) Design criteria for children's web portals: the users speak out. *Journal of the American Society for Information Science and Technology* 53 (2). 79-94.

Last D. A., O'Donnell A. M. and Kelly A. E. (2001). The Effects of Prior Knowledge and Goal Strength on the use of Hypertext. *Journal of Educational Multimedia and Hypermedia* 10, (1) 3–25.

Leader, L.F., and Klein, J.D. (1996). The effects of search tool type and cognitive style on performance during hypermedia database searches. *Educational Technology Research and Development,* 44(2). 5–15

Leahy, W. and Sweller, J. (2004) Cognitive load and the imagination effect. *Applied Cognitive Psychology* 18(7), 857-73.

Lee, J. and Boling, E. (2008). Information-conveying approaches and cognitive styles of mental modeling in a hypermedia-based learning environment. *Journal of the American Society for Information Science and Technology,* 59(4), 644-661.

Lee J. (2007). The effects of visual metaphor and cognitive style for mental modeling in a hypermedia-based environment. *Interacting with Computers* 19, 614–629

Lee C. H.M., Cheng Y. W., Rai S., Depickere A. (2005) What affect student cognitive style in the development of hypermedia learning system? *Computers and Education.* 45, 1–19

Lee, M. G. (2001). Profiling students' adaptation styles in web-based learning. *Computers and Education*, 36, 121–132.

Lekkas Z. , Tsianos N. , Germanakos P. , Mourlas C. and Samaras G. (2009). Implementing Affect Parameters in Personalized Web-Based Design. *Human Computer Interaction*. 5612, 320-329

Lembaga peperiksaan Malaysia (2004). *Laporan prestasi SPM 2003*. Jilid II Siri Buku Laporan Prestasi. Kuala Lumpur: Kementerian Pelajaran Malaysia

Li X. and Gu X. (2009). A Conceptual Model of Personal Learning Environment Based On Shanghai Lifelong Learning System. *Proceedings of the 17th International Conference on Computers in Education [CDROM*]. Hong Kong: Asia-Pacific Society for Computers in Education.

Liao, H. C. (2007). *The relationship between student-teacher cognitive styles and students' English performance in junior high school* (Unpublished master's thesis). National Chengchi University, Taiwan

Liaw S. S,. Huang H. M, and Chen G. D. (2007) Surveying instructor and learner attitudes toward e-learning. *Computers and Education*. 49, 1066-1080.

Lim D. H., Morris M.L., and Yoon S. W. (2006). Combined Effect of Instructional and Learner Variables on Course Outcomes within An Online Learning Environment. *Journal of Interaction in Online Learning*. 5(3), 255-269.

Lin, B. and Hsieh, C. (2001). Web-based teaching and learner control: a research view. *Computers and Education*. 37, 377–386.

Linn M.C, Clark D., and Slotta J.D. (2003) WISE design for knowledge integration, *ScienceEducation*. 87, 517–538

Linn, M. C., Davis, E. A., and Bell, P. (2004). *Internet environments for science education*. Mahwah, NJ: Erlbaum.

Liu, M., and Reed, W. M. (1994). The relationship between the learning strategies and learning styles in a hypermedia environment. *Computer in Human Behavior,* 10(4). 419-434.

Loch B. and Donovan D. (2006) . Progressive Teaching of Mathematics with Tablet Technology. *e-Journal of Instructional Science and Technology (e-JIST),* 9(2)

Luk, S. C. (1998). The relationship between cognitive style and academic achievement. *British Journal of Educational Technology*, 29(2), 137-147.

Madar A. R., and Buntat Y., (2008). Gaya Kognitif dan Visualisasi Pelajar Melalui Perisian Multimedia [Congnitive Style and Visualization of Students Through Multimedia Software]. *Masalah Pendidikan, 31 (1)*. pp. 181-192. ISSN 0126-5024.

Magoulas G. D., Chen S. Y., Dimakopoulos D., (2004). A Personalised Interface for Web Directories based on Cognitive Styles. *Lecture Notes in Computer Science*, 3196, 159-166.

Magoulas G.D., Papanikolaou K.A., and Grigoriadou M. (2003). Adaptive web-based learning: accommodating individual differences through system's adaptation. *British Journal of Educational Technology*, 34, 511–527, http://www.ed.gov/Technology/techconf/2000/mccombs_paper.html.

Magoulas, G.D., Papanikolaou, K., and Grigoriadou, M. (2003). Adaptive web-based learning: accommodating individual differences through system's adaptation. *British Journal of Educational Technology*, 34 (4). 511–527.

Magoulas G. D. and Chen, S.Y. (2006). *Advances in Web-Based Education: Personalized Learning Environment*. Idea Group Publishing

Mbajiorgu, N. and Reid, N. (2006), Factors Influencing Curriculum Development in Chemistry. A Physical Science Practice Guide. Edinburgh: Higher Education Academy Physical Science Centre.

Martinez, M.(1999). An Investigation into Successful Learning: Measuring the Impact of Learning Orientation, A Primary Learner-Difference Variable, on Learning. Dissertation (University Microfilms No. 992217).

Martinez, M. (2000). Designing Learning Objects to Mass Customize and Personalize Learning. In D. Wiley (Ed.). *The Instructional Use of Learning Objects (on line version).* section 3.1, Association for Instructional Technology and Association for Educational Communications and Technology (AIT/AECT).

Martinez M. (2001). Key Design Considerations for Personalized Learning on the Web.

Educational Technology and Society 4(1)

Martinez, M. and Bunderson, C. V. (2001). Foundations for Personalized Web Learning

Environments. *Journal of Asychronous Learning Networks*, 4(2).

Martinez E. F, Chen S. Y, Liu X. (2008). Investigation of behavior and perception of digital library users: A cognitive style perspective. *International Journal of Information Management* , 28, 355–365

Martinsen, O. and Kaufmann, G., (1999). Cognitive style and creativity. In M. Runco and S. Pritsker (Eds.). *Encyclopedia of creativity*, Vol 1, pp. 273-282. New York, Academic Press.

Marais, P., and Jordaan, F. (2000). Are we taking symbolic language for granted? *Journal of Chemical Education,* 77(10). 1355–1357.

Mason, E. J. (1996). *Qualitative Researching*. London: SAGE Publications.

Mason, E. J. and Bramble, W. J. (1997). *Research in Education and the Behavioral Sciences :*

Concepts and Methods. Dubuque: Brown and Benchmark Publishers.

Mayer R. E. and Moreno R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Journal of Educational Psychologist, 38*(1), 43–52

Mayer, R. E., and Moreno, R. (2002). Animation as an aid to multimedia learning. *Educational Psychology Review, 14,* 87-99.

McCombs, B. L. (2000). Assessing the role of educational technology in the teaching and learning process: a learner-centered perspective. *Educational Technology Conference*

Mccoy, L. P. (1991). *The Effect of Geometry Tool Software on High School Science Teaching*. 10, 51-57

McDonald S. and Stevenson R. J. (1998). Effects of text structure and prior knowledge of the learner on navigation in hypertext *Human Factors* 40(1) 18–27.

McLouhlin, C. (1999). The implications of the research literature on learning styles for design of instructional material. *Australian Journal of Educational Technology*,15(3). 222-241

McLoughlin, C. and Lee, M. J. W. (2010). Personalised and self-regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software. *Australasian Journal of Educational Technology*, 26(1), 28-43.

McLoughlin, C. and Lee, M.J.W. (2009). Personalised learning spaces and self-regulated
learning: Global examples of effective pedagogy. *Ascilite ConferencesAuckland 2009.* http://www.ascilite.org.au/conferences/auckland09/procs/mcloughlin.pdf

McNamara, C. 1999. *Basics of conducting focus groups.* Retrieved 2 Feb 2012 from http://www.mapnp.org/library/evaluatn/focusgrp.htm

McNaught C. (1982). Relationship Between Cognitive Preferences and Achievement in Chemistry. *Journal of Research in Science Teaching*. 19(2). 177-186

McNeil S. (2009). Visualizing Mental Models: Understanding Cognitive Change to Support Teaching and Learning of Multimedia Design and Development Retrieved 12 Disember 2010 from, http://it.coe.uga.edu/itforum/paper111/McNeil.pdf

Means B., Olson K. (1995). *Technology's role in education reform*. Retrieved 17 March 2010 from http://www.ncrel.org/tplan/cbtl/execsum.htm.

Meor Ibrahim Kamaruddin, Zainuddin Abu Bakar, and Johari Surif, (2004) *Relationship Between Cognitive Styles,Levels Of Cognitive Thinking And Chemistry Achievement Among Form Four Science Students.* Project Report. Universiti Teknologi Malaysia. (Unpublished)

Merriam, S. B. (1988). *Case Study Research in Education : A Qualitative Approach*. California and Oxford: Jossey-Bass Publishers.

Messick, S. (1976). *Individuality in learning*. San Francisco: Jossey-Bass

Mistler-Jackson M., and Songer N.B. (2000*).* Student motivation and Internet technology: Are studentsempowered to learn science*. Journal of Research in Science Education*. 37, 459–479

Moallem M. (2007). Accommodating Individual Differences in the Design of Online Learning Environments: A Comparative Study *Journal of Research on Technology in Education, 40*(2), 217–245

Mohd Fauzi M. M. (2006). *Tajdid mendepani cabaran di era globalisasi.* Utusan Malaysia. 22 September 2006

Molphy M. and Pocknee C. (2005). Chemistry online in a constructivist environment Paper presented at Ascilite conference, The Queensland University of Technology,
Brisbane, 4-7 December 2005

Moore, M. G. (1989). Three types of interaction. *The American Journal of Distance Education*, 3(2). 1−6.

Moreno, R., and Mayer, R. E. (2000). A Learner-Centered Approach to Multimedia Explanations: Deriving Instructional Design Principles from Cognitive Theory. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning.* Retrieved September 27, 2011, from http://www.imej.wfu.edu/articles/2000/2/05/

Morgan, D. L. (1998). Practical strategies for combining qualitative and quantitative methods: Applications to health research. *Qualitative Health Research, 8*, 362-376.

Morgil I., Yavuz S., Oskay Ö. Ö. and Arda S. (2005). Traditional and computer-assisted learning in teaching acids and bases. *Chemistry Education Research and Practice,* 6(1). 52-63.

Motschnig-Pitrik R., Derntl M. (2003). Can the web improve the effectiveness of person-centered learning? Case study on teaching and living webengineering. *Proceedings of International Conference WWW/Internet (ICWI'03).*Algarve, Portugal, pp. 651-658.

Mulford, D. R., and Robinson, W. R. (2002). An inventory for alternate conceptions among firstsemester general chemistry students. *Journal of Chemical Education, 79*(6). 739-744.

Muirhead, B., and Juwah, C. (2004). Interactivity in computer-mediated college and university education: A recent review of the literature. *Educational Technology and Society,* 7(1). 12−20.

Nakhleh, M., (1992). Why Some Students Don't Learn Chemistry: Chemical Misconceptions, *Journal of Chemical Education*, 69(3), 191-196.

Nahum T. L., Hofstein A. Mamlok-Naaman R., and Bar-Dov Z. (2004). Can final examinations amplify students' misconceptions in chemistry?. *Chemistry Education : Research and Practice*, 5(3).

Nam, C.S. and Smith-Jackson, T. L. (2007) Web-Based Learning Environment: A Theory-BasedDesign Process for Development and Evaluation., *Journal of Information Technology Education,* 6.

Narey M. J. (2003). Technology in fine arts classroom. In Tomei L. A (2003). *Challenges of teaching with technology across the curriculum: issues and solution*. (211-239). United State : Information Science Publishing

NCREL (2002). Technology in Education. Retrieved March 2, 2010 from http://www.ncrel.org/sdrs/areas/te0cont.htm

Nelson, P. (2002). Teaching chemistry progressively: From substances, to atoms and molecules, to electrons and nuclei. *Chemistry Education: Research and Practice, 3*, 215–228.

Neo, M., Neo T., and Yap W. (2008). Students' perceptions of interactive multimedia mediated web-based learning: A Malaysian perspective. *Ascilite 2008 Conference,* Melbourrne, 30 Nov - 3 Dec

Nersessian, N. (2007). Mental modeling in conceptual change. In S. Vosniadou (Ed.). *Handbook of conceptual change*. Mahwah, NJ: Lawrence Erlbaum.

Neuman, W.L (2000). *Social Research Methods: Qualitative and Quantitative Approaches.* Nedham Heights. MA: Ally and Bacon

Newby T. J, Stepich D. A, Lehman J. D. and Russell J. D. (2006). *Educational Technology for teaching and learning.* 3rd ed. New Jersy : Pearson/Merrill Prentice Hall.

Neuman W. L. (2002). *Social research method.* Allyn and Bacon

Nor Haslina Ahmad Daman Huri. (2006). *Tahap kefahaman pelajar tingkatan empat aliran sains mengenai konsep ikatan kimia berpandukan gambarajah*. UTM Thesis

Noremiyati Azhari (2007). *Tahap penguasaan topic ikatan kimia di kalangan pelajar-pelajar sarjana muda sains serta pendidikan (Kimia)*. UTM Thesis

Nornadiah M. R., Wah Y. B. (2011). Power Comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling Tests. *Journal of Statistical Modeling and Analytics*, 2(1), pp21-33

Nguyen D. M., Kulm G., Alalawi S. Using Web-based Practice to Enhance Mathematics
Learning and Achievement. *Journal of Interactive Online Learning* . 3(3)

Niaz, M. (1987). The Role Of Cognitive Factors In The Teaching Of Science. *Research In Science And Technological Education*. 5**.** 7-16

Nicoll, G., (2001). A Report Of Undergraduates' Bonding Alternative Conceptions, *International Journal of Science Education,* 23(7). 707–730.

Nicoll, G. (2003). A qualitative investigation of undergraduate chemistry students' macroscopic interpretations of the submicroscopic structure of molecules. *Journal of Chemical Education,* 80(2). 205–213.

Niglas, K. (2004). *The combined use of qualitative and quantitative methods in educational research*. Tallinn, Estonia: Tallinn Pedagogical University.

Novak, I.D. (2002). Meaningful learning: The essential factor for conceptual change in limited or inappropriate prepositional hierarchies leading to improvement of learners. *Science Education,* 86(4),587-571.

Oh. E. and Lim, D. (2005) Cross Relationships between Cognitive Styles and Learner
Variables in Online Learning Environment. *Journal of Interactive Online Learning, 4(1).*

Oversby, J. (2000). Models in explanations of chemistry. In J.K. Gilbert and C.J. Boulter (Eds.). *Developing models in science education* (pp. 227-251). Dordrecht,: Kluwer.

Ozmen, H. (2004). Some Student Misconceptions in Chemistry : A Literature Review of Chemical Bonding. *Journal of Science Education and Technology,*13(2).

Özmen, H., Demircioğlu, H. and Demircioğlu, G. (2009). The effects of conceptual change texts accompanied with animations on overcoming 11th grade students' alternative conceptions of chemical bonding, *Computers and Education*, 52, 681-695.

Özmen, H. (2008). Determination of students' alternative conceptions about chemical equilibrium: A review of research and the case of Turkey. *Chemistry Education: Research and Practice*, 9, 225-233.

Pabucu A. And Geban O. (2006). Remediating misconceptions concerning chemical bonding through conceptual change text. *Journal of education.* 130, *184-192*

Palmquist, R. A. and Kim, K.-S. (2000) .Cognitive style and on-line database search experience as predictors of Web search performance. *Journal of the American Society for Information Science,* 51, 6, 558-66,

Papageorgiou G. and Johnson P., (2005). Do particle ideas help or hinder pupils' understanding of phenomena?, *International Journal of Science Education*. 27, 1299-1317.

Park, H. M. (2008). *Univariate Analysis Normality Test Using SAS, Stata and SPSS.* Technical Working Paper. The University Information Technology Services (UITS) Center for Statistical and Mathematical Computing, Indiana University.

Payne R. K. (2002). *Understanding Learning: the How, the Why, the What. Aha!* Process Inc

Peklaj C. (2003). Gender, abilities, cognitive style, and students' achievement in cooperative learning. *Horizon of psychology.* 12(4). 9-22

Peneheva E. S. And E. V. Papazova, (2006), Cognitive styles and value. *A Multicultural Research Conference Honolulu*, Hawaii, January 6-8, 2006

Pereira, M. P., and Pestana, M. E. M. (1991). Pupils' representations of models of water. *International Journal of Science Education*, 13(3). 313–319.

Peterson, R., andTreagust,D. F. (1989). Grade-12 students' misconceptions of covalent bonding and structure. *Journal of Chemical Education* 66: 459–460.

Piaget, J. (1963). *The child's conception of the world*. Patterson, NJ: Littlefield, Adams.

Prain V. and Waldrip B., (2006). An exploratory study of teachers' and students' use of multi-modal representations of concepts in primary science, *International Journal of Science Education*. 28, 1843-1866.

Pusat Perkembangan Kurikulum (2001). *Sukatan Pelajaran Kurikulum Bersepadu Sekolah Menengah Kimia*. Kuala Lumpur: Dewan Bahasa Dan Pustaka.

Ravialo, A., (2001). Assessing Students' Conceptual Understanding of Solubility Equilibrium, *Journal of Chemical Education,* 78(5). 629–631.

Reddi U. V. and Mishra S. (2003). *Educational Multimedia A Handbook for Teacher-Developers Commonwealth Educational Media Centre for Asia*, New Delhi.

Reed B. B. (1986).*The Effects of Computer Assisted Instruction on Achievement and Attitudes of Underachievers in High School Biology*. Dissertation Abstracts International. 47(4).1270-

Rekkedal T. and Qvist-Eriksen S. (2003). *The Students' Need for and Satisfaction with*
Student Support Services. An Evaluation Study among NKI e-Learning Students
Bekkestua. Retrieved 5 April 2010, from
http://learning.ericsson.net/socrates/doc/norwayp4.pdf

Retalis S, Paraskeva F, Tzanavari A, and Garzotto F. (2004). Learning Styles and Instructional Design as Inputs for Adaptive Educational Hypermedia Material Design. Paper presented at the "Information and Communication Technologies in Education" 4th Hellenic Conference with International Participation, Athens, Greece.

Riecken D. (2000). Personalized views of personalization. *Communications of the ACM*, 43(8). 27-28

Riding, R., and Cheema, I. (1991). Cognitive styles: An overview and integration. *Educational Psychology*, 11(3 and 4). 193-215

Riding R. and Rayner S. (1998). *Cognitive styles and learning strategies: Understanding style differences in learning and behaviour*. London: David Fulton.

Riding R. (2002). *School Learning and Cognitive Style*. London : David Fulton Publishers.

Riecken D. (2000). Personalized views of personalization. *Communications of the ACM*, 43(8). 27-28

Robert Wyss (2002). Field Independent/Dependent Learning Styles and L2 Acquisition.

Journal of ELT Newsletter.

Robinson, W. (2003). Chemistry problem-solving: Symbol, macro, micro, and process aspects. *Journal of Chemical Education*, *80*, 978-982.

Roblyer, M. D. (2003). *Integrating educational technology into teaching* .3rd ed. Upper Saddle River, New Jersy: Merrill Prentice Hall.

Rothenberg, Laurence E. (2002), "The three tensions of globalization", *The American Forum for Global Education*. Retrieved Sep. 14, 2007, from http://www.globaled.org/issues/176.pdf

Rowntree, D. (1981). *Statistics Without Tears: A Primer for non-Mathematicians*. Penguin: London

Rubin, H. J., and. Rubin, I. S. (2005). *Qualitative Interviewing – The Art of Hearing Data.* 2nd Edition, Sage Publications: Thousand Oaks, London, New York.

Rumetshofer, H. and Wöß, W. (2003). XML-based adaptation framework for psychological driven e-learning systems. *Educational Technology and Society*, 6(4). 18-29.

Ruttun R. (2009). The Effects of Visual Elements and Cognitive Styles on Students' Learning in Hypermedia Environment. *World Academy of Science, Engineering and Technology.* 49

Russel J.W., Kozma R.B., Jones T., Wykoff .J, Marx N., and Davis J. (1997). Use of simultaneous, synchronized macroscopic, microscopic and symbolic representations to enhance the teaching and learning of chemical concepts. *Journal of Chemical Education*. 74, 330–334

Sadler-Smith, E., and Badger, B. (1998). Cognitive style, learning and innovation. *Technology Analysis and Strategic Management,* 10, 247–265.

Sampson D. and Karagiannidis C. and Kinshuk (2002).Personalised Learning: Educational, Technological and Standardisation Perspective. *Interactive Educational Multimedia*, 4, 24-39

Sampson C. and Karagiannidis D. (2004). Adaptation rules relating learning style research and learning objects meta-data. Workshop on Individual Difference in Adaptive Hypermedia. *3rd International Conference on Adaptive Hypermedia and Adaptive Web-Based System (AH2004).* Eidhoven, Netherlands

Saeed, N., Yang, Y., and Sinnappan, S. (2009). Emerging Web Technologies in Higher Education: A Case of Incorporating Blogs, Podcasts and Social Bookmarks in a Web Programming Course based on Students' Learning Styles and Technology Preferences. *Educational Technology and Society*, *12* (4). 98–109.

Sanger, M.J., and Badger, S.M. II. (2001). Using computer-based visualization strategies to improve students' understanding of molecular polarity and miscibility. *Journal of Chemical Education,* 78, 1412–1416.

Santally M. I and Senteni A. (2005). Adaptation Models for Personalisation in Web-based Learning Environments. *Malaysian Online Journal of Instructional Technology,* 2(1)

Santally, M., (2003). *Learning and Perceptual Styles Consideration in the Design of Hypermedia Courseware for Distance Learning*, Institute of personnel and Development, Mauritius.

Scarsbrook A. F., Graham, R. N. J. And Perriss R. W. (2005). The scope of educational resources for radiologists on the internet. *Clinical Radiol.* 60(5), 524–530.

Schaffert S. and Hilzensauer W. (2008). On the way towards Personal Learning Environments – Seven crucial aspects. Retrieved 4 September 2009 from, http://www.elearningeuropa.info/files/media/media15971.pdf

Severance, C., Hardin, J., and Whyte, A. (2008). The coming functionality mash-up in PersonalLearning Environments. *Journal of Interactive Learning Environments* , *16* (1), 47-62.

Shubbar, K.E. (1990). Learning the visualization of rotations in diagrams of three dimensional structures. *Research in Science and Technological Education*, 8(2). 145 -154.

Siemens, G. (2007). PLEs – I acronym, therefore I exist. *elearnspace: learning, networks, knowledge, technology, community* [weblog], Retrieved 13 May 2010 from, http://www.elearnspace.org/blog/archives/002884.html

Simsek N. and Çakır O. (2009) Effect of Personalization on Students' Achievement and Gender Factor in Mathematics Education. *International Journal of Social and Human Sciences*, 3

Siragusa, L., and Dixon, K. C. (2005). *A theoretical framework for research and development into sound online learning in higher education*. Peer reviewed paper presented at the AARE 2005 International Education Research Conference. Creative Dissent: Constructive Solutions, New South

Specht, M. and Oppermann, R. (1998). ACE - Adaptive Courseware Environment. The *New Review of Hypermedia and Multimedia,* 4, 141-161.

Sirhan G. (2007) Learning difficulties in Chemistry: An Overview. *Journal of Turkish Science Education*. 4(2)

Smith, P. and Dalton, J. (2005). *Getting to grips with learning styles.* Retrieved 9 September 2009, from http://www.ncver.edu.au/research/proj/nd3103b.pdf,

Stamovlasisa D. , Tsitsipisb G. and Papageorgiou G. (2010). The effect of logical thinking and two cognitive styles on understanding the structure of matter: an analysis with the random walk method. *Chemistry Education Research and Practice 2009*. 11, 173–181

Steele D. M. (2003). *The influence of cognitive style on insight problem solving*. Master Thesis Buffalo State College, State University of Newyork

Sieber, S. (1973). Integration of fieldwork and survey methods. *American Journal of Sociology*,78, 1335-1359

Stieff, M. (2005). Connected chemistry: A novel modeling environment for the chemistry classroom. *Journal of Chemical Education*, 82, 489–493.

Stinner, A. (1995). Science textbooks: Their present role and future form. In S. M. Glynn and R. Duit (eds.). *Learning science in the schools,* pp. 275-296. Mahwah, NJ: Lawrence Erlbaum Associates.

Suchanska M.and Keczkowska J. (2007). Some aspects of employing the Moodle platform as a tool for enhancing the teaching and learning process, *Proeeding International Conference on Computer as a Tool EUROCON*, pp. 2465.

Sutton, C. (1996). Beliefs about science and beliefs about language. *International Journal of Science Education,* 18, 1-18.

Taber,K. S. (1997). Student understanding of ionic bonding: Molecular versus electrostatic framework? *School Science Review* 78, 85–95.

Taber, K. S. (1998). An alternative conceptual framework from chemistry education. *International Journal of Science Education*, *20*(5). 597–608.

Taber, K. (2000). Chemistry lessons for universities?: A review of constructivist ideas. *University Chemistry Education.* 4, 63–72.

Taber K. S. (2002). *Alternative Conceptions In Chemistry: Prevention, Diagnosis And Cure.* London: The Royal Society of Chemistry.

Taber, K.S. (2002). *Chemical misconception: Prevention, diagnosis and cure*. Vol. 1 Theoretical background. London: Royal Society of Chemistry.

Tan O. B. (2010). *Score A+ in SPM Chemistry*. Bangi : Penerbitan Pelangi Sdn Bhd.

Tang, H. (2003). *The interaction of cognitive style and learning environment on student performance, course satisfaction, and attitude toward computers*. Unpublished doctoral dissertation, The University of Memphis.

Tasker, R., and Dalton, R. (2006). Research into practice: Visualisation of the molecular world using animations. *Chemistry Education Research and Practice, 7*(2). 141-159.

Thagard, P. (2010) How brains make mental models. *Conference on Model-Based Reasoning in Campinas*, Brazil

Tien L. T., Teichert M. A. and Rickey D., (2007). Effectiveness of a MORE laboratory module in prompting students to revise their molecular-level ideas about solutions, . *Journal of Chemical Education*, 84, 175-180.

Tin O. T. (2010). *Achieve! SPM Chemistry Model Test Paper*. Shah Alam : Oxford Fajar Sdn Bhd.

Tinajero, C., and Paramo, M. F. (1997). Field dependence-independence and academic achievement: A re-examination of their relationship. *British Journal of Educational Psychology,* 67(2). 199-212.

Tinajero C. and Paramo F. M., (1998). Field dependence-independence cognitive style and academic achievement: a review of research and theory. *Europen Journal Psychology Education.* 13, 227-251

Tomei L. A. (2008). *Encyclopedia of Information Technology Curriculum Integration*. New York : Information Science Reference

Triantafillou, E., Pomportsis, A. and Demetriadis, S. (2003) The design and the formative evaluation of an adaptive educational system based on cognitive styles, *Computers and Education*, 41, 87-103.

Treagust, D.F. and Chittleborough, G. (2001) Chemistry : A matter of understanding representation; In J. Brophy (Ed.). *Subject-Specific Instructional Methods and Activities* (Vol 8, pp 239-267). Oxford: Elsevier Science Ltd.

Treagust, D. F., Chittleborough, G. D., and Mamiala, T. L. (2003). The role of sub-microscopic and symbolic representations in chemical explanations. *International Journal of Science Education,* 25(11). 1353–1369.

Treagust D. F., Chittleborough G. D. and Mamiala T. L., (2001). The function of macroscopic, symbolic and sub-microscopic representations in explaining concepts in high school chemistry, Sci. Teach. Learn., Retrieved January 30, 2010, from http//tigersystem.net/aera2002/view proposaltext. asp?proplD=5854.

Trinidad S. 2003. Working with technology-rich learning environment: Strategies for success. In Khine M. S. and Fisher D. (Eds.). *Technology-rich learning environments: A future perspective* (pp. 97-113). Singapore: World Scientific

Tsaparlis, G. (1997). Atomic and molecular structure in chemical education: A critical analysis from various perspectives of science education. *Journal of Chemistry Education, 74,* 922-925.

Toffler, A. (1970). *Future shock*. London: Bodley Head

Tuckey, H., Selvaratnam, M., and Bradley, J. (1991). Identification and rectification of student difficulties concerning three-dimensional structures, rotation, and reflection. *Journal of Chemical Education*, 68(6). 460 - 464.

Tuckey, H., and Selvaratnam, M. (1993). Studies involving three-dimensional visualisation skills in chemistry. *Studies in Science Education,* 21, 99–121.

Turner P., and Sobolewska E. (2009) Mental models, magical thinking and individual differences. Journal on Humans in ICT Environments 5 (1). 90–113 Gilbert, J. K., and Rutherford, M. (1998a). Models in explanations Part 1: Horses for courses? *International Journal of Science Education*, *20*(1). 83–97.

Turro, N. J. (2005) Constructivism and Information Technology at Columbia: A Journey from the Wilderness to the Promised Land. 2004 George C. Pimentel Award *Journal of Chemistry Education*, 9, 1292−1299.

Tversky, B., and Morrison, J.B. (2002). Animation: Can it facilitate? *International Journal of Human-Computer Studies,* 57, 247–262.

Van Der Veer, C. G., and Del Carmen Puerta Melguizo, M. (2003). Mental models. In J. A. Jacko and A. Sears (Eds.). *The human-computer interaction handbook: Fundamentals, evolving technologies,and emerging applications* (pp. 52-80). Uitgever: Lawrence Erlbaum and Associates.

Vermaat H., Terlouw C. and Dijkstra S. (2003) Multiple Representations in Web-based Learning of Chemistry Concepts. A paper presented at the 84th Annual Meeting of the American Educational Research Association, Special Interest Group Technology, Instruction, Cognition and Learning; Chicago IL, USA, April 21 -25, Vermunt, J. D. (1998). The regulation of constructive learning processes. *British Journal of Educational Psychology,* 68, 149-171.

Vernadakis N., Zetou E., Tsitskari E., Giannousi M. and Kioumourtzoglou E. (2008) Student attitude and learning outcomes of multimedia computer-assisted versus traditional instruction in basketball. *Education and Information Technologies*. 13(3). 167-183

Viola S. R., Giretti A. and Leo T. (2007). On-Line Detecting Differences in "Meaningful Learning" Behaviours and their Evolution: A Data Driven Approach. *International Journal of Computing and Information Science. 5(2). 63-73*

Wang, D. (2004). Enhancing Interactivity and individualized learning in online learning
environment : A Literature Approach. New Horizon in Web Based Learning, *3rd International Conference on Web-Based Learning*. Beijing, 8-11 August

Wang C. Y. (2007). The Role of Mental-Modeling Ability, Content Knowledge, and Mental Models in General Chemistry Students' Understanding About Molecular Polarity Unpublished doctoral dissertation, University of Missouri – Columbia

Webster, R. (2001). Interfaces for E-learning: Cognitive styles and software agents for Web-based learning support. Retrieved May 15, 2009 from http://www.medfac.unimelb.edu.au/ascilite2001/pdf/papers/websterr.pdf

White K. W. and Weight B. H. (2000). *The Online Teaching Guide: A handbook of attitudes, strategies, and techniques for the virtual classroom*. MA: Allyn and Bacon

Whitman L. (2009). The Effectiveness of Interactivity in Computer-Based Instructional Diagrams. *Human-Computer Interaction*. Part II, 899–908

Wild, M. (1996) Mental models and computer modelling. *Journal of Computer Assisted Learning,* 12(1).

Williamson V.M., Abraham M.R. (1995) The effects of computer animation on the particulate mental models of college chemistry students. *Journal of Research in Science Teaching*, 32, 521–534

Wijekumar, K. (2005). Creating effectiveweb-based learning environments: Relevant research and practice. *Innovate* 1 (5). Available at, http://www.innovateonline.info/index.php?view=articleandid=26andaction=synopsis

Wiersma, W. (1995). *Research Methods in Education : An Introduction*. 6th ed. Needham Heights, MA: Allyn and Bacon.

Williamson, V.M. and Abraham, M.R. (1995). The Effects of Computer Animation on the Particulate Mental Models of College Chemistry Students. *Journal of Research in Science Education*, 32, 521-534

Witkin, H.A., Oltman, P.K., Raskins, E., and Karp, S.A. (1971). *A Manual For The Group Embedded Figures Test*. Palo Alto, California: Consulting Psychologists Press.

Witkin, H.A., Moore, C.A., Goodenough, D.R. and Cox, P.W. (1977). Field dependent and field independent cognitive styles and their educational implications. *Review of Educational Research,* 47, 1-64

Wright T. (2003). Images of Atoms. *Journal of Australian Science Teachers,* 491, 18-24

Wu, H.-K., Krajcik, J.S., and Soloway, E. (2000). Using Technology to Support the Development of Conceptual Understanding of Chemical Representations. In B. Fishman and S. O'Connor-Divelbiss (Eds.). *Fourth International Conference of the Learning Sciences* (pp. 121-128). Mahwah, NJ: Erlbaum.

Wu, H.-K., Krajcik, J. S., and Soloway, E. (2001). Promoting understanding of chemical representations: Students' use of a visualization tool in the classroom. *Journal of Research in Science Teaching,* 38(7). 821-842.

Yecan E. (2005). *Learning strategies of students with different cognitive styles in a hypermedia environment*. Middle East Technical University. Master Thesis

Yezierski E. J. and Birk J. P. (2006). Misconceptions about the Particulate Nature of Matter. Using Animations To Close the Gender Gap. *Journal of Chemistry Education*, 83 (6), 954

Yin, R. K., (2003). *Case study research: Design and methods*. London: Sage Publications.

Zailinawati Abu Hassan, Schattner, P. and Mazza D. (2006). Doing A Pilot Study: Why Is It Essential? Journal of Academy of Family Physician of Malaysia. 1(2 and 3). Retrieved 2 September 2009 from, http://ejournal.afpm.org.my/v1n2-3/pdf/MFP2006v2-3_research_notes1.pdf, Zhang, L. F. (2004). Field-dependence/independence: Cognitive style or perceptual ability?—Validating against thinking styles and academic achievement. *Personality and Individual Differences*, 37, 1295–1311.

Zyngier, D. (2008) (Re) Conceptualising Student Engagement: doing education not doing time, Teaching and Teacher Education, 24(7), 1765-1776.