USER MODELS BASED ON STUDENTS' MOTIVATION, ACHIEVEMENT, AND PROBLEM-SOLVING SKILLS THROUGH LEARNING ORIENTATIONS PERSONALIZED LEARNING ENVIRONMENT

NORAZRENA ABU SAMAH

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (Educational Technology)

Faculty of Education
Universiti Teknologi Malaysia

FEBRUARY 2013

To my beloved mother and father,
Abu Samah Bakar and Jamilah Selamat

To my beloved and understanding husband,
Khairul Anuar Abdul Rahman

ACKNOWLEDGEMENT

Assalamualaikum w. b. t.

In the name of Allah, the Most Gracious, the Most Merciful. First, praise to Allah, the God of all universe. Second, my sincere appreciation goes to my supervisors Dr. Noraffandy Yahaya and Associate Professor Dr. Mohamad Bilal Ali, whose guidance, careful reading and helpful comments were valuable. Their timely and efficient contribution helped me shape this into its final form. I am also deeply indebted to my co-supervisor Professor Dr. Kinshuk for his invaluable advice and supervision alongside my study in Canada.

I am also indebted to Universiti Teknologi Malaysia (UTM) for funding my Ph.D. study. I also wish to thank the Faculty of Education, its leadership and the staff for providing me with an academic base, which has enabled me to take up this study. I am particularly grateful to Professor Dr. Sabine Graf, Professor Dr. Vive Kumar and Professor Dr. Maiga Chang for their worthy contribution. I am also indebted to my colleagues, Noor Dayana Abd Halim, Nurbiha A. Shukor, Dayana Farzeeha Ali and Mohd Shafie Rosli. Special thanks, tribute and appreciation to all of them and to those whose names are not mentioned here who have contributed to the successful completion of this study. Finally, I am grateful to all my family members for their understanding of the importance of this work, to my husband Khairul Anuar Abdul Rahman, my mother Jamilah Selamat and my father Abu Samah Bakar.

ABSTRACT

The need has arisen for the consideration of individual differences to be taken into account in order to allow learners to engage in and be responsible for their own learning. It is also desirable for learners to be able to acquire the following qualities, namely: to retain information for longer periods, to apply knowledge more effectively, to have positive attitudes towards their respective subjects, to have more interest in learning materials, to score higher grades, and to have higher motivation levels. Therefore, the Learning Orientations Model that covers individual intentions, emotions, social, and cognitive aspects is referred to in attempting to overcome problems involving fractions and motivation in learning fractions. For that reason, learning materials involving fractions are developed by referring to a preferred general learning environment, learning modules, and sequencing methods of each Learning Orientations Profile. In addition, the learning materials are delivered through animation of worked examples in a personalized learning website, called the Fractions Website. The website is developed with the integration of the following functions, namely: learner-self interactive functions, learner-learner/instructor interactive functions, learner-interface interactive functions, and learner-content interactive functions. As a result, the learning through the website was found to be able to improve students' achievements and problem-solving skills in fractions. Moreover, students have been found to be satisfied with, and enjoyed learning using the Fractions Website. Apart from that, Learning Orientations Profiles of some students are found to be not relatively static. Thus, the interactions on the Fractions Website are referred to for use in synthesizing user models for static and non-static Learning Orientations Profile learners.

ABSTRAK

Keperluan untuk menitikberatkan perbezaan individu telah meningkat bagi menggalakkan pelajar melibatkan diri dan bertanggungjawab terhadap pembelajaran mereka. Pelajar juga diharapkan dapat mencapai kualiti berikut iaitu: mengekalkan maklumat yang diperoleh lebih lama, mengaplikasikannya dengan lebih efektif, menampilkan sikap yang lebih positif terhadap subjek yang dipelajari, lebih berminat terhadap bahan pembelajaran, memperoleh markah lebih tinggi dan mempunyai tahap motivasi yang lebih tinggi. Oleh itu, Model Orientasi Pembelajaran yang merangkumi aspek niat, emosi, sosial dan kognitif seseorang individu dirujuk untuk mengatasi masalah yang melibatkan pecahan dan motivasi dalam mempelajari pecahan. Oleh sebab itu, bahan pembelajaran yang melibatkan pecahan telah dibangunkan dengan merujuk kepada persekitaran pembelajaran umum, modul pembelajaran dan kaedah susunan penyampaian yang menjadi pilihan pelajar bagi setiap Profil Orientasi Pembelajaran. Tambahan pula, bahan pembelajaran tersebut disampaikan dalam bentuk animasi "contoh jalan kerja" melalui laman web pembelajaran personalisasi yang diberi nama *Fractions Website*. Laman web tersebut dibangunkan dengan mengintegrasikan fungsi-fungsi berikut iaitu: fungsi interaksi antara pelajar dengan diri sendiri, fungsi interaksi antara pelajar dengan pelajar lain/tenaga pengajar, fungsi interaksi antara pelajar dengan antara muka dan fungsi interaksi antara pelajar dengan kandungan pembelajaran. Hasilnya, pembelajaran melalui laman web tersebut didapati mampu meningkatkan pencapaian dan kemahiran penyelesaian masalah pelajar dalam pecahan. Di samping itu, pelajar didapati berpuas hati dan seronok belajar melalui *Fractions Website*. Selain itu, Profil Orientasi Pembelajaran sebahagian pelajar didapati tidak statik. Maka, interaksi dalam *Fractions Website* dirujuk untuk mensintesis model pengguna bagi pelajar yang mempunyai Profil Orientasi Pembelajaran yang statik dan tidak statik.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADDIE	-	Analysis, Design, Develop, Implement and Evaluate
AEHA	-	Adaptive Educational Hypermedia Applications
AHA!	-	Adaptive Hypermedia Architecture
CL	-	Conforming Learner or Conformance
FW	-	Fractions Website
LO	-	Learning Orientations
LOM	-	Learning Orientations Model
LOQ	-	Learning Orientations Questionnaire
MQ	-	Motivation Questionnaire
PL	-	Performing Learner or Performance
PLE	-	Personalized Learning Environment
PS	-	Problem-Solving
RL	-	Resistant Learner or Resistance
SILPA	-	System for Intentional Learning and Performance Assessment
TANGOW	-	Task-based Adaptive learNer Guidance On the WWW
TL	-	Transforming Learner or Transformance

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Currently, we are rapidly approaching an era in which technology is widely used in the field of education. The difference between the use of technology in education and its use in general is that technology in education is only concerned with its impact on the teaching and learning process. For example, it is involved in the following areas, namely: in delivering learning materials and contents, evaluating students' achievements, providing feedback and encouraging collaborative learning among students; in the education system (Hanna & de Nooy, 2003). Furthermore, the use of technology in education only differs in how much the technology is used in each subject and how the technology is applied in it. This includes different kinds of learning environments, such as online learning, blended learning and the use of electronic hardware as a teaching aid. Moreover, the use of technology in education will involve the use of computers, projectors, or other kinds of electronic hardware and software in the teaching and learning process (Goodwin, 2008).

In addition, broadening the use of technology in education has attracted many researchers to study its effectiveness on students' achievement, performance, cognition, emotions, intentions, etc. (Hanna & de Nooy, 2003; Liu et al., 2008; Morrison & Guenther, 2000; Trinidad, 2003). They found that technology in education supports the students' construction of knowledge (Morrison & Guenther, 2000), supports learner-centred learning (Trinidad, 2003) and improves learning and educational outcomes (Hanna & de Nooy, 2003). In addition, Liu, et al. (2008) found that the use of technology in mathematics learning concentrates on learners' differences, reduces misconceptions and hence, also improves students' performance. Furthermore, research carried out into the topic of fractions shows positive results in the use of technology when learning fractions (Abdul Rahman & Abu Samah, 2011; Goodwin, 2008). Goodwin (2008) found that students' learning outcomes were accelerated after learning whilst using technology. On the other hand, results from the research done by Abdul Rahman and Abu Samah (2011) showed a positive result in relation to students' achievements in fractions and an increase in their satisfaction. In addition, clearly defined educational objectives are the beginning of any successful use of technology (Gagné et al., 2005).

Furthermore, there is a need to consider individual differences in order to ensure that learners are engaged, take responsibility for their own learning development, and are provided with the necessary challenges and opportunities for self-development and learning (Abdul Rahman & Abu Samah, 2011; Aviram et al., 2008; Jung & Graf, 2008; Keller, 2010; Kim, 2009; Thompson, 2008). This is aligned with the term of "personalized learning environment", in which personalized instruction emphasizes individual differences and needs, while providing a student-centred approach (Alias, Jamaluddin, & Hashim, 2005; Capuano et al., 2009; Gilbert & Han, 2002; Kim, 2009; F. Liu, 2007). The personalized learning environment is found to be most suitable in an online medium, since online learning provides individualized learning and offers personalization in learning (Abdul Rahman & Abu Samah, 2011; Abu Samah, Yahaya, & Bilal Ali, 2011; Alias, Jamaluddin, & Hashim, 2005; Martinez, 1999, 2002).

Apart from that, many researchers found online learning to be more beneficial to students. Research by Gagné, et al. (2005) found that, through online learning, students are able to diagnose their strengths and limitations, make effective decisions, create new ideas and take responsibility for their own learning. Moreover, students' motivation could easily be measured through their interactions in online learning (Muñoz-Organero, Muñoz-Merino, & Kloos, 2010). Werby (2009) and Chyung (2007) also found that online learning supports meaningful learning and improves motivation. Subsequently, there are researchers who have developed learner or user models based on learners' interactions in online learning in order to help teachers understand the learning process from the perspective of learners (Fouad, Harb, & Nagdy, 2011). The model mainly included learners' cognitive development or interest in learning (Qiu & Zhao, 2009). The synthesization of a user model specifically based on a personalized learning environment was also focused on by Fouad, Harb and Nagdy (2010) and Qiu and Zhao (2009). However, the model did not consider the impact of PLE towards motivation, achievement and problem-solving skills.

Therefore, user modelling in a personalized learning environment, representing students' interactions in the learning environment and the effect of the learning environment on motivation, achievements and problem-solving skills has been synthesized in this research. The changes of motivation factors included in the user modelling have had an influence on students' motivation to learn. Therefore, the user modelling is used to analyze the relationship between motivation factors with students' achievements and problem-solving skills after learning through the personalized learning environment. Further explanation on motivation, achievements, problem-solving skills, personalized learning environments and a user model will be detailed in the following section.

1.2 Background of the Problem

This research was carried out to enhance motivation in the study of mathematics and overcoming problems in fractions, by considering individual differences based on the Learning Orientations Model. Therefore, this section will discuss the background of the problems, which are namely: motivation in mathematics, problems with learning fractions and personalized learning based on the Learning Orientations Model, as follows:

1.2.1 Motivation in Mathematics

The diversity of mathematics' usage in the real world has confirmed the importance of mathematics as a body of knowledge. However, there is a belief that mathematics has no connection with the real world and also that it is a difficult subject to learn (Smith, 1995; Usiskin, 2007). This phenomenon has resulted in high anxiety among learners in relation to the study of mathematics (Uusimaki & Nason, 2004). They tend to feel less confident in mathematics and have no interest in learning the subject. What is more, motivation to learn is influenced by an individual's beliefs, interest and emotions (Gagné, et al., 2005). Therefore, a negative belief in mathematics, entertaining a low value of mathematics, high mathematical anxiety and a low self-concept of one's ability in mathematics become the factors behind low motivation levels towards mathematics (Alsup, 2005; Ball, 1990; Hembree, 1990; Newton, 2008, 2009; Stipek, 2002; Swars, Daane, & Giesen, 2006; Tirosh, 2000; Turner et al., 2003; Vinson, 2001; A. Wigfield & Eccles, 2000).

Motivation has an important role to play in students' achievements in mathematics. If students are not motivated to learn mathematics, they tend to place less value on the knowledge of mathematics (Newton, 2009). These problems were found have a relationship with the low achievement rate in mathematics among learners (Woolf et al., 2010). These may also lead to a low self-concept of ability towards the learning because it is related to current belief in the learner's own ability, together with expectations of success in the future (Newton, 2009). As a result, a student can have a low self-concept of his/her ability, become a low achiever, place less value on mathematics and have high mathematical anxiety. In addition to that, motivation is important in problem-solving generally (Jonassen, 2011) and is therefore important in solving mathematical problems. In addition, students with a high self-concept of ability in learning are found to have high problem-solving skills, an ability to perform better and to be a high achiever (Adeyemo, 2010). Therefore, in order to tackle problems with mathematics, the motivation level of students in learning mathematics needs to be taken into account and must be increased.

Accordingly, motivation can be observed through students' behaviour (Gagné, et al., 2005), and online learning is able to capture the behaviour through students' interactions and the total time spent interacting with the system (Muñoz-Organero, Muñoz-Merino, & Kloos, 2010). In addition to that, online behaviour could be observed through students' participation in online learning activities and social activities, such as messaging, chatting and using forums (Chyung, 2007). Chyung (2007) also found that interactive and social activity options motivate students more to log in frequently to the system and, thus, to learn. However, there is still a lack of research into the use of technology that specifically considers investigating the following: students' motivation in terms of how they value mathematics; their mathematical anxiety and, also, their self-concept of ability in mathematics. Therefore, this research is carried out to investigate the effectiveness of technology towards these motivational aspects, which were introduced by Newton (2009). These motivational aspects also are investigated regarding mathematics learning, specifically on the topic of fractions. Further explanation on fractions will be discussed in the following subsection.

1.2.2 Problems in Learning Fractions

Specifically, fractions is a topic in mathematics, which is the continuity of the topic of proportionality and also fundamental to the topic of algebra (Adjiage & Pluvinage, 2007). In the topic of fractions, students learn operations involving the following, namely: proper and improper fractions with the same, or different, numerators or denominators; equivalent fractions that involve simplification and sequencing of fractions and interpretation of fractions using graphical methods or set notations. The knowledge of fractions is important for use in daily life. As an example, a whole cake needs to be distributed equally to six children. In this matter, a knowledge of fractions is needed to be applied for a fair distribution of cake slices to the six children. However, difficulties involving fractions are found among students (Fandiño Pinilla, 2007). In addition, many researchers (e.g. Gould, 2005; Peng & Idris, 2008; Tengku Zainal, Mustapha, & Habib, 2009; Tirosh, 2000) have found mistakes and misconceptions involving fractions.

In addition, unfamiliarity or not having much experience in solving problems involving fractions could be the cause of errors or an inability to solve the multi-step problems of fractions (Ya-Amphan, 2002). Moreover, students' inability to solve multi-step problems in fractions can be attributed to the lack of problem-solving skills, prior knowledge of mathematical concepts and language-based misconceptions (Amen, 2006). In addition, there are mistakes found from the preliminary investigation towards students' answer scripts on fractions. These are, namely: mistakes in the last answer, mistakes in calculation and mistakes in copying information from the questions. Inaccurate computational skill will also contribute to poor problem-solving skills (Zentall & Ferkis, 1993). What is more, low skills in problem-solving will contribute to low motivation in learning fractions and hence a reduced desire to learn more about them (Gearhant et al., 1999; Jonassen, 2010, 2011; Malloy & Jones, 1998; Pantziara & Philippou, 2007). Mathematics performance was also found to be involved with students' problem-solving processes. As found by Gagatsis, Elia, and Mousoulidis (2006), students need to master the basic knowledge of problem-solving to be able to answer complex problems in mathematics.

Therefore, there is a need to develop students' problem-solving skills to overcome the following, namely: their mistakes and misconceptions involving fractions, increasing their desire to learn fractions, improve their cognitive development in fractions and then encourage them to become good, or better, problem solvers (Gagné, et al., 2005; Jacob & Sam, 2008; Tripathi, 2009). According to Jonassen (2011), problem-solving requires intentional learning. Students must have the intention to learn and be responsible for their own learning in order to solve multi-step problems involving fractions. This is aligned with the Intentional Learning Theory presented by Martinez (1999), which not only considered students' cognitive style in learning but also deliberated further on their intentions and emotions for better and more effective learning. However, there is still a lack of research using the Intentional Learning Theory in improving the learning of mathematics, especially fractions.

On the other hand, it has been found that the animation of worked examples could aid in the understanding of problem-solving steps (Scheiter, Gerjets, & Schuh, 2010). Moreover, technology enables the development of an interactive environment that increases achievement, and encourages problem-solving and motivation in mathematics (Jacob & Sam, 2008; Serin, 2011). Therefore, the learning of fractions in this research is delivered through the animation of worked examples by Jonassen (2011) in order to familiarize students with problem-solving steps in fractions. Moreover, the sequence of observation, interpretation and application helps students better understand the process of problem-solving (Vat, 2009). In addition to that, this research emphasized the importance of individual intention in learning, and the preference of a problem-solving approach as suggested by Martinez (2001), since an individual has different preferences in solving problems (Treffinger & Selby, 2004). Further elaboration on personalized learning based on individual differences by Martinez (2001) will be discussed in the following subsection.

1.2.3 Personalized Learning based on Learning Orientations Model

Several studies have related the importance of students' individual differences being taken into account when preparing learning (Aviram, et al., 2008; Jung & Graf, 2008; Kim, 2009). Accordingly, the Intentional Learning Theory by Martinez (1999) (which focused on students' conative, affective, social and cognitive aspects) is referred to in this research in order to design the learning modules of fractions learning. The consideration of the conative aspect is found to be able to connect knowledge and feelings to actions (Schoeman, 2005). The Learning Orientations Model introduced in the theory categorized students into four Learning Orientations Profiles, which are namely: Transforming Learner, Performing Learner, Conforming Learner and Resistant Learner. Therefore, in order to emphasize individual differences and needs (Capuano, et al., 2009; Kim, 2009; F. Liu, 2007), personalized learning modules have been developed for students with different Learning Orientations Profiles. This also assists to fill in the gap of "no such personalized learning" that is considered on the Learning Orientations Profiles introduced by Martinez (1999). This is aligned with a suggestion by Vat (2009), stating that the learning design must place emphasis on students' own learning orientations, since teaching and learning are ongoing processes. Besides that, there is a need for a formulation of a user model, based on a personalized learning environment, which will give overall information as to how students learn and if they benefitted from the learning.

Subsequently, research on user modelling in individualized and personalized learning has blossomed in recent years. The user model is designed to represent characteristics of users or students, including preferences, knowledge, competencies, tasks and objectives (Aroyo et al., 2006; Choi & Kang, 2012; Qiu & Zhao, 2009). The user model helps teachers to monitor students' learning processes and to see clearly the outcome and effectiveness of the learning (Fouad, Harb, & Nagdy, 2011). Therefore, it is necessary to fill in the gap of no research done on user modelling for each Learning Orientations Profile with regard to achievement, problem-solving skills and motivation. Accordingly, a user model is synthesized for each learner's profile based on students' motivation before, during and after learning through a personalized learning website, called "Fractions Website". It is also based on their performance in learning fractions and problem-solving skills.

1.3 Statement of the Problem

As explained previously, motivation plays an important role in students' achievements in mathematics. Therefore, an individual's beliefs, interests and emotions should be considered in the preparation of learning since these are the factors that influence students' motivation. These also have an effect on students' performance and motivation to learn (Pantziara & Philippou, 2007). Specifically, the topic of fractions is the continuity of the topic of proportionality and the basis of the topic of algebra (Adjiage & Pluvinage, 2007). There are students who believe that fractions have no meaning in their lives. For that reason, many mistakes and misconceptions with regard to fractions are found by researchers among students. These involve operations of addition, subtraction, multiplication and division involving the following, namely: fractions, equivalent fractions (which includes comparing fractions and line intervals), interpretation of fractions, simplification of fractions, sequential fractions, reasoning and the concept of fractions as a whole. Furthermore, the lack of problem-solving skills will contribute to a low performance in fractions, since it contains multi-step problems.

Therefore, in order to improve students' performance and motivation in fractions, a personalized learning website, called the Fractions Website, has been developed on the topic of Fractions for Form One students. The website emphasizes individual differences in order to increase learner motivation towards learning (Aviram, et al., 2008; Lim, Morris, & Yoon, 2006). A website is the learning medium chosen by the researcher since it is found to be perfect for individualized learning (Alias, Jamaluddin, & Hashim, 2005; Martinez, 1999, 2002). In addition, it enables instructors to monitor students' progress easily, present content specifically, identify learners' differences easily and increase students' satisfaction, which will also increase their motivation levels (Lim, Morris, & Yoon, 2006). In addition, the website is developed by referring to Intentional Learning Theory, since this theory covers individually cognitive aspects, intention, as well as social and emotional aspects, which have an effect on students' problem-solving (Jonassen, 2010, 2011).

Furthermore, the worked examples approach in learning fractions by Jonassen (2011) is referred to in order to enhance students' problem-solving skills. Students' engagement in problem-solving activities could improve their problem-solving abilities (Adeyemo, 2010; Zentall & Ferkis, 1993). This study is expected to improve students' achievements and motivation in fractions and enhance their problem-solving skills in mathematics, especially regarding fractions. In addition, this study is expected to synthesize a user model for each Learning Orientations Profile in regard to students' participation in the Fractions Website, achievement, problem-solving skills and motivation in learning fractions.

1.4 Objective of the Study

This research is conducted with objectives aiming to:

a) Design and develop a personalized learning website for Form One's topic of fractions (called the Fractions Website) by including Interactivity Functions.

b) Design and develop learning modules by referring to the Learning Orientations Model.

c) Investigate the effect of the Fractions Website towards students':
   i. Achievements in fractions.
   ii. Problem-solving skills in fractions.
   iii. Motivational factors (which are the value of fractions, mathematical anxiety on fractions and self-concept of ability in learning fractions).
   iv. Learning orientations..

d) Analyze students' learning orientations, namely, self-motivation, self-directed strategic planning and learning autonomy in correlation to their:
   i. Achievement scores in fractions.
   ii. Problem-solving skills scores in fractions.
   iii. Motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions).

e) Synthesize a user modelling system based on Learning Orientations Profiles in relation to students':
   i. frequency of interactions on the Fractions Website;
   ii. achievement scores in fractions;
   iii. problem-solving skills scores in fractions;

iv. motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions).

1.5 Research Questions

This research is conducted with regard to corresponding questions, which are namely:

a) Does Fractions Website have an effect on students':
   i. Achievements in fractions?
   ii. Problem-solving skills in fractions?
   iii. Motivational factors (which are the value of fractions, mathematical anxiety on fractions and self-concept of ability in learning fractions)?
   iv. Learning orientations?

b) What is the correlation between students' learning orientations, namely: self-motivation, self-directed strategic planning and learning autonomy with their:
   i. Achievement scores in fractions?
   ii. Problem-solving skills scores in fractions?
   iii. Motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions)?

c) What is the user modelling based on Learning Orientations Profiles in relation to students':
   i. frequency of interactions on Fractions Website;
   ii. achievement scores in fractions;
   iii. problem-solving skills scores in fractions;

iv. motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions)?

1.6 Scope and Research Delimitation

The scope of this study is a focus solely on 35 Form One students from a school in Johor, chosen using purposive sampling, whereby special needs students and students from Fully Residential Schools are excluded from this research. Further explanation on purposive sampling will be discussed in Chapter 3, Section 3.3. This research is focused on the following, namely: students' achievements in fractions; problem-solving skills in fractions; learning orientations profiles and motivational aspects of self-concept of ability in learning fractions, the value of fractions and mathematical anxiety about fractions before and after learning through a personalized learning website, called the Fractions Website. In addition to that, students' interactions on the website are analyzed in order to synthesize a user model for static and non-static learning orientations profiles. It discusses the effect of the website on their achievements, problem-solving skills and motivations. Other demographic factors such as gender, family background, race and students' interest in online learning are not considered in this research. The Fractions Website is integrated with five interactivity functions, namely: learner-learner, learner-self, learner-instructor, learner-interface and learner-content interactive functions, as recommended by Chou, Peng and Chang (2010).

Further, learning modules of fractions are constructed by referring to the Curriculum Specifications for Mathematics Form One for the topic of fractions, provided by Curriculum Development Centre of the Ministry of Education Malaysia (Ministry of Education Malaysia, 2002). Moreover, the learning modules are designed for Transforming Learners, Performing Learners and Conforming Learners, based on the Intentional Learning Theory by Martinez (1999). This includes the Learning Orientations Model, the Learning Orientations Questionnaire and Website

Design Guidelines for each learning orientations profile. There are no specific learning modules designed for Resistant Learners, since it has been found that this category of learner will avoid using learning to achieve academic goals set by others (Chapman, 2006). Moreover, the learning modules are delivered through the Fractions Website using a worked examples approach, as suggested by Jonassen (2011).

1.7 Rationale

This research is conducted to develop a personalized learning website for the topic of Fractions for Form One students. A Personalized Learning Environment (PLE) is chosen since many studies have proven its effectiveness towards learning, involving differences in each student (Aviram, et al., 2008; Gilbert & Han, 2002; Görgün et al., 2005; Retalis et al., 2004). The content is best delivered through the web, because of the practicality of the medium. which has the following qualities: it enables non-linear structures and navigation, contains multimedia presentations, distributes cross-platform systems and allows for immediate updates, responses and feedback (Wang & Yang, 2005). In addition, online learning encourages students to learn more, since the learning provides interactive and social options (Chyung, 2007). This could help in improving value placed by students' on mathematics knowledge (Newton, 2009). This could then lead to their becoming better achievers (Woolf, et al., 2010).

Additionally, the Intentional Learning Theory by Martinez (1999) is referred to in the construction of the learning modules, since this theory not only focuses on cognitive aspects, but also emphasizes students' conative, affective and social aspects (Chapman, 2006) that connect their knowledge and feelings to action (Schoeman, 2005). The learning modules are delivered through worked examples as suggested by Jonassen (2011) in order to enhance students' problem-solving skills. Problem-solving was found to have correlation with motivation in learning and the desire to learn more (Jonassen, 2010, 2011; Pantziara & Philippou, 2007). Therefore, students need to master problem-solving in order to be able to answer complex mathematical problems in the future (Gagatsis, Elia, & Mousoulidis, 2006).

1.8 Theoretical Framework

Figure 1.1 is the theoretical framework of this research. In analysing the needs of students in learning, differences in students' individual ways of learning have to be taken into account to conduct better and more effective learning (Aviram, et al., 2008; Jung & Graf, 2008; Kim, 2009; Retalis, et al., 2004; Weber, Martin, & Cayanus, 2005). After conducting the needs analysis; students' intentions and their emotional, social and cognitive styles play an important role in an effective learning process. For that reason, the Intentional Learning Theory by Martinez (2001) that covers the whole-person perspectives, namely: conative or intentional, affective or emotional, social and cognitive, is used in this research. Therefore, the Learning Orientations Model is used to categorize students based on the Learning Orientations Profiles of the following categories: Transforming Learner or Transformance, the Performing Learner or Performance, the Conforming Learner or Conformance and the Resistant Learner or Resistance. The design guidelines on the preferences of each learner profile, as constructed by Martinez (2001), are then referred to in the development of learning modules for each learner profile on the Fractions Website. These are specifically for Transforming, Performing and Conforming Learners. Alternatively, the Resistant Learner learns through their own choice of learning module selected from the provided list.

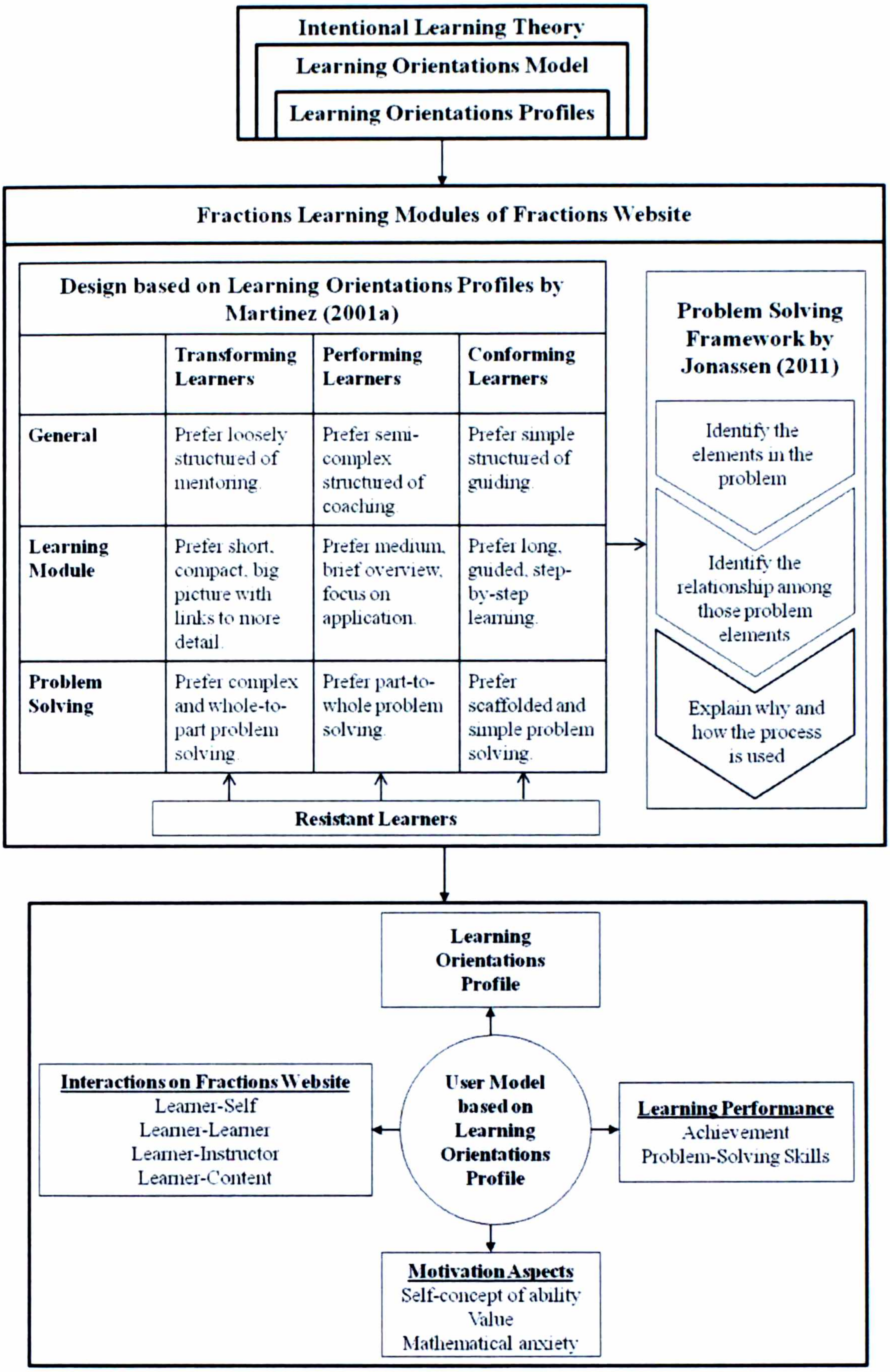

Figure 1.1: Theoretical Framework

In addition, students learn fractions by using worked examples, as suggested by Jonassen (2011) and based on their preferred general environment of learning, overview of modules and problem-solving approach, as shown in Martinez's design guidelines. Steps in the worked examples are, namely: identifying the elements in the problem, identifying the relationship between those problem elements and explaining why and how the process is used. This learning approach will be applied differently based on students' learning orientations. Since Transforming Learners prefer complex and whole-to-part problem-solving, a holistic problem-solving approach will be used for them. Conversely, Performing Learners prefer part-to-whole problem-solving, which is also called an analytical approach. At the same time, Conforming Learners prefer scaffolded and simple problem-solving. Therefore, the problem-solving approach for them is analytical and fully guided. On the other hand, Resistant Learners are given the freedom to choose any problem-solving approach since they resist both learning and following instructors' educational goals.

Consequently, the effectiveness of learning fractions through the Fractions Website is then investigated through analysis of students' achievements in Pre Test and Post Test results. In addition, students' problem-solving skills before and after learning through the website are measured using the Problem-Solving Rubric. This contains the following: problem-solving skills scores for accuracy of problems classification, identification of initial conditions, accuracy of equation, accuracy of answer estimate, unit consistency and accuracy of answers. In addition, students' motivational aspects regarding the value of fractions as well as anxiety generally relating to mathematics, fractions and self-concept of ability in learning fractions are analyzed before, during and after learning through the website. Finally, a user model is synthesized based on students' achievements, motivation and problem-solving skills for each Learning Orientations Profile. This is performed together with monitoring the frequencies of their interactions between themselves, other learners, instructors and learning content on the Fractions Website.

1.9 Research Framework

The research framework of this research is divided into four phases, which are namely: the Analysis Phase, the Design and Developmental Phase, the Implementation Phase and the Evaluation Phase, as shown in Figure 1.2. In the Analysis Phase, problems are analysed and identified after thorough reading of previous studies. The sample of this research is also determined in this phase using the purposive sampling method. The research instruments, namely: Pre Test, Post Test, System Analysis Questionnaires, System Effectiveness Questionnaires and Fractions Learning Modules for Transforming, Performing and Conforming Learners, are then constructed in the Design and Developmental Phase. These instruments are subsequently validated and tested for reliability, together with the Learning Orientations Questionnaires. The other research instruments, namely the Motivation Questionnaires and Problem-Solving Rubric, are used for data analysis purposes. In addition to that, the personalized learning website called Fractions Website is developed in this phase.

The Implementation Phase of this research is then divided into three stages, which are the Pre Test, Treatment and Post Test stages. In the Pre Test Stage, the Pre Test and the Motivation Questionnaires are distributed to the samples undertaking this study. The learning orientations profile of each student is subsequently determined through online Learning Orientations Questionnaires. After that, in the Treatment Stage, students learn through the particular learning environment on the Fractions Website that suits their learning orientations profile. In the middle of the implementation period, another Learning Orientations Questionnaires and Motivations Questionnaire will be administered to the samples of this study. Students will then learn in a different learning environment that suits their new learning orientations profile. However, if their profile remains the same, the student will stay in the same learning environment until the end of the Treatment Stage. Finally, in the Post Test Stage, another Motivation Questionnaire and Learning Orientations Questionnaire will be administered, together with the Post Test and a System Effectiveness Questionnaire.

Analysis Phase

1. Analyses of problems in Mathematics, especially in the topic of Fractions from previous studies.
2. Sample of this study is determined.

Design and Developmental Phase

1. Construction, validation and reliability testing of research instruments.
2. Design and development of Fractions Website

Implementation Phase

Pre Test

1. The first Motivation Questionnaires are administered to the sample of this study, together with Pre Test.
2. Then, the first Learning Orientations Questionnaires are answered online by the sample of this study to determine their learning orientations profiles.

Treatment

1. The sample of this study is asked to enter the learning environment that suits their learning orientations profiles provided in the Fractions Website.
2. In the middle of implementation period, the second Motivation Questionnaires are administered to the sample of this study.
3. Then, the second Learning Orientations Questionnaires are answered online by the sample of this study to determine their learning orientations profiles.
4. Afterwards, the sample will change the learning environment if their learning orientations profiles are changed on the second Learning Orientations Questionnaires. Otherwise, they stayed in the same learning environment until the end of the implementation period.

Post Test

1. The third Motivation Questionnaires are administered to the sample of this study, together with Post Test.
2. Then, the third Learning Orientations Questionnaires are answered online by the sample of this study to determine their learning orientations profiles.

Evaluation Phase

Data analysis based on Research Questions

Figure 1.2: Research Framework

Finally, in the Evaluation Phase, data collected in the Implementation Phase will be analyzed corresponding to the research questions. Table 1.1 simplifies the following information, namely: the research instruments involved in the data collection, the development of the Fractions Website and the design of the learning modules for Transforming Learners, Performing Learners and Conforming Learners that correspond to the objectives and questions of this research. The research procedure, data analysis and research instruments will be detailed in Chapter 3.

Table 1.1: The Relationship between the Research Objectives, Questions and Instruments

Research Objectives	**Research Questions**	**Research Instruments**
a) Design and develop a personalized learning website for Form One's topic of Fractions (called the Fractions Website) by including Interactivity Functions.		i. System Analysis Questionnaires ii. Interactivity Functions Documents iii. System Development Checklist
Design and develop learning modules by referring to the Learning Orientations Model.		i. Fractions Learning Modules for Transforming, Performing and Conforming Learners
Investigate the effect of Fractions Website upon students': i. Achievements in fractions. ii. Problem-solving skills in fractions. iii. Motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions). iv. Learning orientations.	Does Fractions Website have an effect upon students': i. Achievements in fractions? ii. Problem-solving skills in fractions? iii. Motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions)? iv. Learning orientations?	i. Pre Test ii. Post Test iii. Problem-Solving Skills Rubric on Pre Test and Post Test iv. Motivation Questionnaires during Pre Test, in the middle of learning and during Post Test v. Learning Orientations Questionnaires during Pre Test, in the middle of learning and during Post Test vi. System Effectiveness Questionnaires
Analyze students' learning orientations, which are self-motivation, self-directed strategic planning and learning autonomy in correlation to their: i. Achievement scores in fractions. ii. Problem-solving	What is the correlation between students' learning orientations, which are self-motivation, self-directed strategic planning and learning autonomy with their: i. Achievement scores in fractions?	i. Motivation Questionnaires during Post Test ii. Post Test iii. Problem-Solving Skills Rubric on Post Test iv. Learning Orientations Questionnaires during

skills scores in fractions. iii. Motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions).	ii. Problem-solving skills scores in fractions? iii. Motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions)?	Post Test
Synthesize a user modelling based on Learning Orientations Profiles in relation to students': i. frequency of interactions on Fractions Website; ii. achievement scores in fractions; iii. problem-solving skills scores in fractions; iv. motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions).	What is the user modelling based on Learning Orientations Profiles in relation to students': i. frequency of interactions on Fractions Website; ii. achievement scores in fractions; iii. problem-solving skills scores in fractions; iv. motivational factors (which are the value of fractions, mathematical anxiety about fractions and self-concept of ability in learning fractions)?	i. Online data logging database of Fractions Website ii. Pre Test iii. Post Test iv. Problem-Solving Skills Rubric on Pre Test and Post Test v. Motivation Questionnaires during Pre Test, in the middle of learning and during Post Test vi. Learning Orientations Questionnaires during Pre Test, in the middle of learning and during Post Test

1.10 Importance of the Study

The importance of this study is very relevant for Malaysia's Ministry of Education, mathematics teachers and Form One students, as follows:

1.10.1 Importance for the Education Ministry of Malaysia

The development of a personalized learning website on the topic of Fractions for Form One students will be one of the strategies of Malaysia's Ministry of Education in accomplishing the mission in developing individual with high mathematical thinking and problem-solving skills by using educational technology (Curriculum Development Centre, 2011). This is in line with the effectiveness of the website in delivering knowledge and learning contents to students of all ages (Bull & Bell, 2008; Hu & Webb, 2009; Kilday & Kinzie, 2009; Wegerif, 2007). Therefore, it is hoped that the website can be a tool by which to enhance students' problem-solving skills in mathematics, especially in the topic of fractions, and to produce students who are able to face future challenges and master the basic knowledge of mathematics. In addition to that, the findings of this research could be used in planning and designing an instructional medium that will be able to improve students' motivation to learn and achieve in the study of mathematics.

1.10.2 Importance for Mathematics Teachers

The development of the website is hoped to help mathematics teachers in delivering the contents of fractions in an easy to understand format to Form One students at all lower secondary schools in Malaysia. This website also helps teachers to deliver the learning of fractions through a problem-solving approach. In addition, teachers can observe students' achievements and performances through the website instantly and easily, from the online assessment provided in the website. These will decrease teachers' respective burdens and help them to deliver an effective knowledge of fractions that will be used widely in higher levels of education. Moreover, the findings of this research could be used in designing teaching aids that are able to improve students' motivation, achievements and problem-solving skills in mathematics.

1.10.3 Importance for Form One Students

The use of the website in learning fractions is hoped to help Form One students to understand and master the basic knowledge of fractions. Furthermore, this will improve their problem-solving skills in fractions. Mastering the basic concepts of fractions, and the problem-solving skills involved, will help them survive and to easily accommodate their new knowledge of fractions, as well as the further subjects involving fractions, at a higher level of education. In addition, the findings of this research could expose students to the learning medium that is able to motivate them to learn more and improve their achievement and problem-solving skills in mathematics.

1.11 Operational Definition

This research uses a few terms relating to technology or variables that may be difficult to understand. Hence, this operational definition could be referred to for further understanding of this study, as follows:

1.11.1 The Personalized Learning Environment (PLE)

Personalized instruction can be defined as instruction that is tailored to the learner's learning preferences and needs (Gilbert & Han, 2002). On the other hand, the learning environment is the setting for the learning to take place (Newby et al., 2006). Therefore, Personalized Learning Environment in this research refers to learning modules of fractions learning that are tailored to each Learning Orientations Profile. The learning modules are referred to in the guidelines by Martinez (2001) in designing a problem-solving approach, general environment of the learning and overview of the modules.

1.11.2 Website

A website offers an ideal technological environment for personalized learning, where learners can be uniquely identified, content can be specifically presented and progress can be individually monitored (Alias, Jamaluddin, & Hashim, 2005). The term of website in this research is used to refer to the personalized learning website for the topic of Fractions for Form One students, named the Fractions Website. The website was developed by referring to the ADDIE Model and contains five interactivity functions, which are namely: learner-self, learner-learner, learner-content, learner-instructor and learner-interface interactive functions, as recommended by Chou, Peng and Chang (2010). These functions are included to promote interactive and social options in order to motivate students to learn and increase their desire to learn more (Chyung, 2007).

1.11.3 Learning Orientations

Learning Orientations describes the disposition of an individual in approaching, managing and achieving their learning intentionally and differently from others. Also, Learning Orientations focuses on the whole-person perspective and can be used as a framework to examine the following, namely: the dynamic flow between deep-seated psychological factors, past and future learning experiences, subsequent choices about cognitive learning preferences, styles, strategies and skills and responses to treatment and, lastly, learning and performance outcomes (Martinez, 1999). There are four Learning Orientations Profiles included in this research, which are namely: Transforming Learner, Performing Learner, Conforming Learner and Resistant Learner as follows:

a) Transforming Learner refers to a highly self-motivated learner, who uses holistic thinking and prefers exploratory learning. The learner will maximize efforts to reach their goals. In addition, they are responsible for their own learning and are easily frustrated if given little learning autonomy.

b) Performing Learner is a self-motivated and focused learner situationally. The learner will minimize efforts and prefer coaching and interaction to reach their goals, and may give up control in lower interest areas.

c) Conforming Learner is a low-risk and extrinsically motivated learner. The learner will maximize efforts in supportive environments and needs continual guidance to achieve short-term goals.

d) Resistant Learner is either an actively or passively resistant learner. The learner will avoid using learning in order to achieve academic goals set by others, but may situationally improve, perform or resist in response to positive or negative learning situations.

1.11.4 Fractions

The topic of fractions that will be learned on the website is specified for Form One students in Malaysia. The subtopic of fractions includes, namely: fractions as part of a whole, equivalent fractions, mixed numbers, proper and improper fractions, as well as the operation of addition, subtraction, multiplication and division of all types of fractions.

1.11.5 Form One Students

The Form One students involved are 13-year-old students at a lower secondary school in Malaysia. 35 students were selected from a lower secondary school in Malaysia, excluding special needs students and Fully Residential Schools.

1.11.6 Database

The database in this research refers to a collection of information, activities and interactions (Newby, et al., 2006) on the Fractions Website. The collection of information includes learning contents, online quizzes and tests, and extra learning from other fractions websites. The activities on the website include a forum, chat, music and games. The database was developed based on five types of interaction, which are namely: learner-self interaction, learner-learner interaction, learner-instructor interaction, learner-interface interaction and learner-content interaction.

1.11.7 Data-Logging

Data Logging refers to logging the activities of students on the developed website, named the Fractions Website. The logging activities are referred to in synthesizing a user model based on students' achievement, problem-solving skills and motivation in learning fractions.

1.12 Summary

This chapter discussed the use and advantages of a personalized learning environment and online learning in education. However, there are problems when learning fractions that need to be mastered in early education. Either one or a combination of factors might cause the problems found, including motivation, mistakes, misconceptions and problem-solving skills. Therefore, a personalized learning website on the topic of fractions, called the Fractions Website, is developed for Form One students. The learning modules on the website emphasizes learners' differences by referring to the Learning Orientations Model proposed by Martinez (1999) and by using worked examples in delivering the learning contents, as suggested by Jonassen (2011). Students' interactions on the Fractions Website are

BIBLIOGRAPHY

Abdul Rahman, K. A., & Abu Samah, N. (2011). Perisian Matematik bagi Tajuk Pecahan untuk Pelajar Berkeperluan Khas. *Jurnal Teknologi Pendidikan Malaysia, 1*(2), 39-47.

Abu Samah, N., & Md Salleh, S. (2009, December 22-24). *Pembangunan Laman Web Matematik berasaskan Sembilan Aspek Pengajaran Gagne bagi Tajuk Kebarangkalian I dan II.* Paper presented at the Seminar Kebangsaan Jawatankuasa Penyelarasan Pendidikan Guru (JPPG) 2009, Impiana Casuarina, Ipoh.

Abu Samah, N., Yahaya, N., & Bilal Ali, M. (2009, November 18-19). *The Relationship between Users' Needs and Their Achievements.* Paper presented at the Education Postgraduate Research Seminar 2009 (EDUPRES 2009), Faculty of Education, Universiti Teknologi Malaysia.

Abu Samah, N., Yahaya, N., & Bilal Ali, M. (2010, October 27-28). *Review on Learning Orientations.* Paper presented at the Education Postgraduate Research Seminar 2010 (EDUPRES 2010), Faculty of Education, Universiti Teknologi Malaysia.

Abu Samah, N., Yahaya, N., & Bilal Ali, M. (2011). Review On Learning Orientations. *Journal of Edupres, 1*(September 2011), 125-134.

Adeyemo, S. A. (2010). Students' Ability Level and Their Competence in Problem-Solving Task in Physics. *International Journal of Educational Research and Technology, 1*(2), 35-47.

Adjiage, R., & Pluvinage, F. (2007). An Experiment in Teaching Ratio and Proportion. *Educational Studies in Mathematics, 65*, 1490-1175. doi: 10.1007/s10649-006-9049-x

Alias, N. A., Jamaluddin, H., & Hashim, M. (2005). Matching the Learning Orientations of Malaysian Online Learners to Their Web Leamiing Environments.

Alsup, J. (2005). A comparison of constructivist and traditional instruction in mathematics. *Educational Research Quarterly, 28*(4), 3-17.

Amen, J. (2006). Using Math Vocabulary Building to Increase Problem Solving Abilities in a 5th Grade Classroom: Middle Institute.

Aripin, R., Mahmood, Z., Rohaizad, R., Yeop, U., & Anuar, M. (2008). *Students' learning styles and academic performance*. Paper presented at the 22nd Annual SAS MalaysiaForum, Kuala Lumpur Convention Center, Kuala Lumpur, Malaysia.

Aroyo, L., Dolog, P., Houben, G. J., Kravcik, M., Naeve, A., Nilsson, M., & Wild, F. (2006). Interoperability in Personalized Adaptive Learning. *Journal of Educational Technology and Society, 9*(2), 4-18.

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

Aziz, S. M., Sicard, E., & Dhia, S. B. (2010). Effective Teaching of the Physical Design of Integrated Circuits Using Educational Tools. *IEEE Transactions on Education, 53*(4), 517-531.

Ball, D. (1990). The mathematical understandings that prospective teachers bring to teacher education. *The Elementary School Journal, 90*(4), 449-466.

Bannan-Ritland, B. (2002). Compter-Mediated Communication, Elearning, and Interactivity: A review of the Research. *The Quarterly Review of Distance Education, 3*(2), 161-179.

Black, T. R. (1999). *Doing quantitative research in the social sciences: An integrated approach to research design, measurement and statistics*: Sage Publications Limited.

Brigham, F. J., Wilson, R., Jones, E., & Moisio, M. (1996). *Best practices: Teaching decimals, fractions, and percents to students with learning disabilities*. Paper presented at the Learning Disabilities forum.

Brooksbank, D., Griffiths, D., Miller, C., Morse, L., Packham, G., Pickernell, D., & Thomas, B. (2002). Teaching the Welsh to Fish. The Reasons for, Structure of and Preliminary Results of Enterprise College Wales (Working Paper No. 22).

Brown, M. (1981). Place value and decimals. In K. M. Hart (Ed.), *Children's understanding of mathematics: 11-16* (pp. 48-65). London, Great Britain: Alden Press.

Brown, T. (2008). Lacan, subjectivity and the task of mathematics education research. *Education Students Mathematics, 68*, 227–245. doi: 10.1007/s10649-007-9111-3

Bruce, C. D., & Ross, J. (2009). Conditions for Effective Use of Interactive On-line Learning Objects: The case of a fractions computer-based learning sequence. *The Electronic Journal of Mathematics and Technology, 3*(1).

Bruning, R. H., Schraw, G. J., Norby, M. M., & Ronning, R. R. (1995). *Cognitive psychology and instruction* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Bull, G., & Bell, R. L. (2008). Educational Technology in the Science Classroom. In J. G.-N. Randy L. Bell, and Julie Luft (Ed.), *Technology in the Secondary Science Classroom* (pp. 1-7): National Science Teachers Association.

Burns, M. (2000). *About Teaching Mathematics: A K-8 Resource* (2nd ed.): Math Solutions Publications.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*: Houghton Mifflin Company Boston.

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.

Carlile, O., & Jordan, A. (2005). It works in practice but will it work in theory? The theoretical underpinnings of pedagogy. In S. Moore, G. O'Neill & B. McMullin (Eds.), *Emerging Issues in the Practice of University Learning and Teaching*. Dublin: AISHE.

Carmagnola, F., Cena, F., Cortassa, O., Gena, C., & Toso, A. (2007, June 25-29). *A preliminary step toward user model interoperability in the adaptive social web.* Paper presented at the International Workshop on Ubiquitous and Decentralized User Modeling (UbiDeUM'2007), Corfu, Greece.

Carro, R. M., Pulido, E., & Rodríguez, P. (1999). Dynamic generation of adaptive Internet-based courses. [doi: DOI: 10.1006/jnca.1999.0094]. *Journal of Network and Computer Applications, 22*(4), 249-257.

Chapman, D. D. (2006). *Learning Orientations, Tactics, Group Desirability, and Success in Online Learning*. Paper presented at the 22nd Annual Conference on Distance Teaching and Learning, Madison, Wisconsin, United States of America.

Chen, C.-T. (2003, December 15-19). *The Development of Computerized Mathematical Learning Dispositions Scale for Elementary School Children*. Paper presented at the 8th Asian Technology Conference in Mathematics, Chung Hua University, Hsin-Chu, Taiwan.

Choi, S.-Y., & Kang, J.-M. (2012). An Adaptive System Supporting Collaborative Learning Based on a Location-Based Social Network and Semantic User Modeling. [Research Article]. *International Journal of Distributed Sensor Networks, 2012*. doi: 10.1155/2012/506810

Cholbi, M. (2007). Intentional Learning as a Model for Philosophical Pedagogy. *Teaching Philosophy, 30*(1), 35.

Chou, C., Peng, H., & Chang, C.-Y. (2010). The Technical Framework of Interactive Functions for Course-Management Systems: Students' Perceptions, Uses, and Evaluations. *Computers & Education, 55*, 1004-1017. doi: 10.1016/j.compedu.2010.04.011

Chyung, S. Y. (2007). Invisible motivation of online adult learners during contract learning. *The Journal of Educators Online, 4*(1).

Clayton, J. (2003). Assessing and Researching the Online Learning Environment. In M. S. Khine & D. Fisher (Eds.), *Technology-Rich Learning Environments: A future Perspective* (pp. 157-186). Singapore: World Scientific Publishing.

Corno, L., & Snow, E. (1986). Adapting Teaching to Individual Differences among Learners. In M. Wittrock (Ed.), *Handbook of Research on Teaching* (pp. 605-629). New-York: Macmillan.

Cramer, K., & Bezuk, N. (1991). Multiplication of Fractions: Teaching for Understanding. *The Arithmetic Teacher, 39*(3), 34.

Cronbach, L., & Snow, R. (1977). *Aptitudes and Instructional Methods: A Handbook of Research on Interactions*: Inrington Publishers.

Curriculum Development Centre. (2011). *Curriculum Specifications Form 1 Mathematics*. Putrajaya: Ministry Of Education Malaysia.

da Costa Pereira, C., & Tettamanzi, A. G. B. (2006). An Ontology-Based Method for User Model Acquisition. In Z. Ma (Ed.), *Soft Computing in Ontologies and Semantic Web* (Vol. 204, pp. 211-229): Springer Berlin Heidelberg.

De Bra, P., Smits, D., & Stash, N. (2006, 1-4 October). *Creating and Delivering Adaptive Courses with AHA!* Paper presented at the Proceedings of the first European Conference on Technology Enhanced Learning, EC-TEL 2006, Crete.

Dennen, V. P., Darabi, A., & Smith, L. J. (2007). Instructor-Learner Interaction in Online Courses: The relative perceived importance of particular instructor actions on performance and satisfaction. *Distance Education, 28*(1), 65-79.

Dewindt-King, A. M., & Goldin, G. A. (2003). Children's Visual Imagery: Aspects of Cognitive Representation in Solving Problems with Fractions. *Mediterranean Journal for Research in Mathematics Education, 2*(1), 1-42.

Dolog, P., Kay, J., & Kummerfeld, B. (2009). *Personal lifelong user model clouds.* Paper presented at the Proceeding of the Lifelong User Modelling Workshop at UMAP.

Dunn, R. S., & Dunn, K. J. (1993). *Teaching secondary students through their individual learning styles: Practical approaches for grades 7-12*: Allyn & Bacon.

Empson, S. B. (2003). Low-performing students and teaching fractions for understanding: An interactional analysis. *Journal for Research in Mathematics Education*, 305-343.

Evans, C., & Sabry, K. (2003). Evaluation of the Interactivity of Web-based Learning Systems: Principles and Process. *Innovations in Education and Teaching International, 40*(1), 89-99.

Fandiño Pinilla, M. I. (2007). Fractions: Conceptual and Didactic Aspects. *Acta Didactica Universitatis Comenianae, 7*, 23-45.

Fazio, L., & Siegler, R. (2012). *Teaching Fractions* (Vol. 22 of Educational Practices).

Felder, R. M., & Silverman, L. K. (1988). Learning and Teaching Styles in Engineering Education. *Engineering Education, 78*(7), 674–681.

Fouad, K. M., Harb, H. M., & Nagdy, N. M. (2011). *Semantic Web supporting Adaptive E-Learning to build and represent Learner Model.* Paper presented at the Second International Conference of E-learning and Distance Education (eLi 2011), Riyadh.

Fuller, T., & Krumova, G. (2005). Learning Demand: Adaptive Learning Instruments. Retrieved 1 December 2009 http://www.learningdemand.com/MOODLE/adaptive_learning_instruments.htm

Gafni, N., Moshinsky, A., & Kapitulnik, J. (2003). A Standardized Open-Ended Questionnaire as a Substitute for a Personal Interview in Dental Admissions. *Journal of Dental Education, 67*(3), 348-353.

Gagatsis, A., Elia, I., & Mousoulidis, N. (2006). Are register of representations and problem solving processes on functions compartmentalized in students' thinking? *Revista Latioamericana de invesigacion en Matematica Educativa, numero especial*, 197-224.

Gagné, R. M., Wager, W. W., Golas, K. C., & Keller, J. M. (2005). *Principles of Instructional Design* (5th ed.). Belmont, CA: Wadsworth, Cengage Learning.

García, B., Márquez, L., Bustos, A., Miranda, G. A., & Espíndola, S. M. (2008). Analysis of Patterns of Interaction and Knowledge Construction in Online Learning Environments: A Methodological Strategy. *Revista Electrónica de Investigación Educativa, 10*(1).

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.

Gearhant, M., Saxe, G. B., Seltzer, M., Schlackman, J., Ching, C. C., & Nasir, N. (1999). Opportunities to learn fractions in elementary mathematics classrooms. *Journal for Research in Mathematics Education, 30*, 286-315.

Gilbert, J. E., & Han, C. Y. (2002). Arthur: A Personalized Instructional System. *Journal of Computing in Higher Education, 14*(1), 113-129.

Goodwin, K. (2008). The impact of interactive multimedia on kindergarten students' representations of fractions. *Issues in Educational Research, 18*(2), 103-117.

Görgün, I., Türker, A., Ozan, Y., & Heller, J. (2005). Learner Modeling to Facilitate Personalized E-Learning Experience. In Kinshuk, D. G. Sampson & P. T. Isaías (Eds.), *CELDA'05: Cognition and Exploratory Learning in Digital Age* (pp. 231-237): IADIS.

Gould, P. (2005). Year 6 Students' Methods of Comparing the Size of Fractions. In P. Clarkson, A. Downton, D. Gronn, A. M. R. Pierce & A. Roche (Eds.), *Building connections: Theory, research and practice (Proceedings of the 28th annual conference of the Mathematics Education Research Group of Australasia)* (Vol. 2, pp. 393-400). Melbourne: MERGA.

Gowen, D. C. (2010). *The Relationship of Motivation and Multiple Intelligence Preference to Achievement from Instruction Using Webquests.* Doctoral Dissertation, Walden University.

Hanna, B. E., & de Nooy, J. (2003). A Funny Thing Happened on the way to the Forum: Electronic Discussion and Foreign Language Learning. *Language Learning & Technology, 7*(1), 71-85.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*(1), 33-46.

Heo, H., Lim, K. Y., & Kim, Y. (2010). Exploratory study on the patterns of online interaction and knowledge co-construction in project-based learning. *Computers & Education, 55*, 1383–1392.

Higgins, K., & O'Keeffe, D. (2004, June 3-4). *An Online Digital Engineering Module Companion using Biomedical Applications.* Paper presented at the Fifth Annual Irish Educational Technology Users' Conference (EdTech 2004), Tralee, Ireland.

Hiramatsu, A., & Tamura, S. (2004). *Method for Atypical Opinion Extraction from Answers in Open-ended Questions*. Paper presented at the Proceedings of IEEE Int. Conf. on Computational Cybernetics (ICCC 2004), Vienna University of Technology, Austria.

Hoffman, B., & Spatariu, A. (2008). The influence of self-efficacy and metacognitive prompting on math problem-solving efficiency. *Contemporary Educational Psychology, 33*, 875-893. doi: 10.1016/j.cedpsych.2007.07.002

Honey, P., & Mumford, A. (1982). *The Manual of Learning Styles*. Berkshire: Peter Honey.

Hu, L., & Webb, M. (2009). Integrating ICT to higher education in China: From the perspective of Activity Theory. *Education Information Technology, 14*, 143-161.

Idris, N. (2006). Creativity in the Teaching and Learning of Mathematics: Issues and Prospects. *Masalah Pendidikan, 29*, 103-114.

Jacob, S. M., & Sam, H. K. (2008, November 2008). *Critical Thinking Skills in Online Mathematics Discussion Forums and Mathematical Achievement.*

Paper presented at the Proceedings of the 13th Asian Technology Conference in Mathematics (ATCM 2008), Thailand.

Jimoh, R. G., Olaniyi, A. S., & Adewole, K. S. (2011). Adoption of Fingerprinting as an Automated Access Control Technique in University Hostels. *ARPN Journal of Systems and Software, 1*(4), 149-153.

Jonassen, D. H. (2000). *Computers as mindtools for schools: Engaging critical thinking*. Columbus, Ohio: Merrill.

Jonassen, D. H. (2010). *Research Issues in Problem Solving*. Paper presented at the The 11th International Conference on Education Research (ICER): New Educational Paradigm for Learning and Instruction, Hoam Convention Center, Seoul National University, Seoul, Korea.

Jonassen, D. H. (2011). *Learning to Solve Problems: A Handbook for Designing Problem-Solving Learning Environments*. New York: Routledge.

Jones, E. R., & Martinez, M. (2001, Oct 23-27). *Learning Orientations in University Web-Based Courses*. Paper presented at the Proceedings of WebNet 2001, Orlando, Florida.

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

Keller, J. M. (2010). What is Motivational Design? *Motivational Design for Learning and Performance* (pp. 21-41): Springer US.

Kilday, C. R., & Kinzie, M. B. (2009). An Analysis of Instruments that Measure the Quality of Mathematics Teaching in Early Childhood. *Early Childhood Education Journal, 36*, 365–372. doi: 10.1007/s10643-008-0286-8

Kim, I.-S. (2009). The Relevance of Multiple Intelligences to CALL Instruction. *The Reading Matrix, 9*(1), 1-21.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.

Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2001). Experiential learning theory: previous research and new directions. In R. J. Sternberg & L. F. Zhang (Eds.), *Perspectives on cognitive, learning, and thinking styles* (pp. 227-248). New York: Lawrence Erlbaum.

Kort, B., Reilly, R., & Picard, R. W. (2001). *External representation of learning process and domainknowledge: Affective state as a determinate of its* *structure and function*. Paper presented at the 10th International Conference on Artificial Intelligence in Education, San Antonio, Texas.

Kuflik, T., Kay, J., & Kummerfeld, B. (2012). Challenges and Solutions of Ubiquitous User Modeling. In A. Krüger & T. Kuflik (Eds.), *Ubiquitous Display Environments* (pp. 7-30): Springer Berlin Heidelberg.

Lazakidou, G., & Retalis, S. (2010). Using computer supported collaborative learning strategies for helping students acquire self-regulated problem-solving skills in mathematics. *Computers & Education, 54*, 3-13. doi: 10.1016/j.compedu.2009.02.020

Lee, S. J. H., & Bull, S. (2008). An Open Learner Model to Help Parents Help their Children. *Technology, Instruction, Cognition and Learning, 6*(1), 29-52.

Lee, Y. L., & Shanks, J. (2008, July 6-13). *Developing a digital game for the instruction of fractions*. Paper presented at the 11th International Congress on Mathematical Education (ICME 11), Monterrey, Mexico.

Legg, S. M. (1991). *Handbook on Testing and Grading*. Gainesville, FL: Office of Instructional Resources, University of Florida.

Leung, E. W. C., & Li, Q. (2007). An experimental study of a personalized learning environment through open-source software tools. *Education, IEEE Transactions on, 50*(4), 331-337.

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

Lin, Z., Ronghuai, H., Xiaochun, W., & Yajun, W. (2008). *Research on Personalized Teaching Model for Individual User in ISI: A Web-Based Learning Systems Platforms*. Paper presented at the 2008 International Conference on Computer Science and Software Engineering.

Liu, C.-C., & Tsai, C.-C. (2008). An analysis of peer interaction patterns as discoursed by on-line small group problem-solving activity. *Computers & Education, 50*(3), 627-639.

Liu, F. (2007). Personalized Learning Using Adapted Content Modality Design for Science Students. *Proceedings of the ECCE 2007 Conference*, 293-296.

Liu, T.-C., Lin, Y.-C., Kinshuk, & Chang, M. (2008, July 1 - 5). *Individual Differences in Learning with Simulation Tool: A Pilot Study*. Paper presented at the 8th IEEE International Conference on Advanced Learning Technologies (ICALT08), Santander.

Ludwig-Hardman, S., & Dunlap, J. C. (2003). Learner Support Services for Online Students: Scaffolding for Success. *International Review of Research in Open and Distance Learning, 4*(1).

Mack, N. K. (1990). Learning fractions with understanding: Building on informal knowledge. *Journal for Research in Mathematics Education, 21*, 16-32.

Malloy, C. E., & Jones, M. G. (1998). An Investigation of African American Students' Mathematical Problem Solving. *Journal for Research in Mathematics Education, 29*(2), 143-163.

Martinez, M. (1999). Intentional Learning in an Intentional World: New Perspectives on Audience Analysis and Instructional System Design for Successful Learning and Performance *Proceedings of the 17th Annual ACM Conference on Systems Documentation* (pp. 211-220). New Orleans, LA: ACM Press.

Martinez, M. (2000). Intentional Learning in an Intentional World: New Perspectives on Audience Analysis and Instructional System Design for Successful Learning and Performance. *Journal of Computer Documentation, 24*(1), 3-20.

Martinez, M. (2001). Key Design Considerations for Personalized Learning on the Web. *Educational Technology & Society, 4*(1), 26-40.

Martinez, M. (2002). Beyond Classroom Solutions: New Design Perspectives for Online Learning Excellence. *Educational Technology & Society, 5*(2), 1-6.

Martinez, M. (2005). Learning Orientation Questionnaire - Interpretation Manual (Includes LOQ Case Studies). Retrieved 1 December 2009 http://www.trainingplace.com/source/research/LOQPKG-Manual2005.pdf

Martinez, M., & Bunderson, C. V. (2001). Foundations for Personalized Web Learning Environments. *Journal of Asychronous Learning Networks, 4*(2).

Md. Yunus, A. S., Mohd Nor, S., & Ismail, H. (1992). Analisis kesilapan masalah-masalah berkaitan nombor perpuluhan dan pecahan bagi pelajar Tahun Lima sekolah rendah. *Jurnal Pendidik dan Pendidikan, 12*, 15-33.

Ministry of Education Malaysia. (2002). *Curriculum Specifications of Mathematics Form One*. Ministry of Education Malaysia.

Mohamad Bilal Ali. (2008). *Pembelajaran Individu Berasaskan Web.* Doktor Falsafah (Teknologi Pendidikan), Universiti Teknologi Malaysia, Skudai.

Molinari, D. L., Blad, P., & Martinez, M. (2005). Seniors learning preferences, healthy self-care practices and computerized education implications. *Online Journal of Rural Nursing and Health Care, 5*(1), 48-58.

Morrison, G., & Guenther, P. (2000). Designing instruction for learning in electronic classrooms. In R. Weiss, D. Knowlton & B. Speck (Eds.), *Principles of effective teaching in the on-line classroom* (pp. 15-21). San Francisco: Jossey-Bass.

Muirhead, B., & Juwah, C. (2004). Interactivity in Computer-Mediated College and University Education: A Recent Review of the Literature. *Journal of Educational Technology & Society, 7*(1), 12-20.

Muñoz-Organero, M., Muñoz-Merino, P. J., & Kloos, C. D. (2010). Student Behavior and Interaction Patterns With an LMS as Motivation Predictors in E-Learning Settings. *IEEE Transactions on Education, 53*(3), 463-470.

Myers, I. B., & Briggs, K. C. (1977). *The Myers-Briggs Type Indicator: Supplementary Manual: Development of Form G*: Consulting Psychologists Press.

Newby, T. J., Stepich, D. A., Lehman, J. D., & Russell, J. D. (2006). *Educational Technology for Teaching and Learning* (3rd ed.). Upper Saddle River, New Jersey: Pearson/Merrill Prentice Hall.

Newstead, K., & Murray, H. (1998). Young Students' Constructions of Fractions. In A. O. K. Newstead (Ed.), *Proceedings of the Twenty-second International Conference for the Psychology of Mathematics Education* (Vol. 3, pp. 295-302). South Africa: Stellenbosch.

Newton, K. J. (2008). An extensive analysis of preservice elementary teachers' knowledge of fractions. *American Educational Research Journal, 45*(4), 1080-1110.

Newton, K. J. (2009). Instructional practices related to prospective elementary school teachers' motivation for fractions *Journal of Mathematics Teacher Education, 12*(2), 89-109. doi: 10.1007/s10857-009-9098-z

Oksuz, C., & Middleton, J. A. (2007). Middle School Children's Understanding of Algebraic Fractions as Quotients. *International Online Journal Science and Mathematics Education, 7*, 1-14.

Own, Z.-Y. (2008). *Situated Learning Incorporated into a Web-Assisted Instruction in Nutritional Chemistry Taken by Learners with Learning-Style Differences.*

Paper presented at the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2008, Las Vegas, Nevada, USA. http://www.editlib.org/p/30105

Own, Z.-Y., Chen, J.-R., & Chuang, K.-H. (2009). Application of Personalized Learning Environment on a Polymer Chemistry Educational Web-Site. *International Journal of Instructional Media, 35*(4), 435-442.

Pantziara, M., & Philippou, G. (2007). Students' Motivation and Achievement and Teachers' Practices in the Classroom. In J. H. Woo, H. C. Lew, K. S. Park & D. Y. Seo (Eds.), *Proceedings of the 31st Conference of the International Group for the Psychology of Mathematics Education* (Vol. 4, pp. 57-64). Seoul: PME.

Panzarasa, P., Opsahl, T., & Carley, K. M. (2009). Patterns and Dynamics of Users' Behavior and Interaction: Network Analysis of an Online Community. *Journal of the American Society for Information Science and Technology, 60*(5), 911-932.

Pawan, F., Paulus, T. M., Yalcin, S., & Chang, C.-F. (2003). Online Learning: Patterns of Engagement and Interaction among In-Service Teachers. *Language Learning & Technology, 7*(3), 119-140.

Pena-Shaff, J. B. (2009). Student patterns of interaction in asynchronous online discussions: Implications for teaching and research. *Research, Reflections and Innovations in Integrating ICT in Education*, 440-445.

Peng, F. S., & Idris, N. (2008). Perwakilan Pecahan Sekolah Rendah: Isu dan Prospek. *Masalah Pendidikan, 31*(1), 41-57.

Pietikäinen, P. S., & Mauno, A. M. (2012, September 23-26). *Conceptual Knowledge and Learning as a Reflection of Students' Motivation.* Paper presented at the SEFI 40th annual conference, Thessaloniki, Greece.

Pillai, P. R. (2008). Influence of HRD Climate on the Learning Orientation of Bank Employees. *Indian Journal of Industrial Relations, 43*(3), 406-418.

Pimta, S., Tayruakham, S., & Nuangchalerm, P. (2009). Factors Influencing Mathematic Problem-Solving Ability of Sixth Grade Students. *Journal of Social Sciences, 5*(4), 381-385.

Pólya, G. (1957). *How to solve it* (2nd ed.). Penguin, London.

Qiu, B., & Zhao, W. (2009, March 7-8). *Student Model in Adaptive Learning System Based on Semantic Web.* Paper presented at the First International Workshop onEducation Technology and Computer Science (ETCS '09).

Reimer, K., & Moyer, P. S. (2005). Third-graders learn about fractions using virtual manipulatives: A classroom study. *The Journal of Computers in Mathematics and Science Teaching, 24*(1), 5-25.

Renkl, A., & Atkinson, R. K. (2003). Structuring the transition fro example study to problem solving n cognitive skill acquisition: A cognitive load perspective. *Educational Psychologist, 38*(1), 15-22.

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

Riechmann, S. W., & Grasha, A. F. (1974). A rational approach to developing and assessing the construct validity of a student learning style scales instrument. *The Journal of Psychology, 87*(2), 213-223.

Romero, C., Ventura, S., Delgado, J. A., & De Bra, P. (2007). *Personalized Links Recommendation Based on Data Mining In Adaptive Educational Hypermedia Systems.* Paper presented at the Proceedings of the second European Conference on Technology Enhanced Learning, EC-TEL 2007, Crete.

Ross, J., & Bruce, C. D. (2009). Student achievement effects of technology-supported remediation of understanding of fractions. *International Journal of Mathematical Education in Science and Technology, 40*(6), 713-727. doi: 10.1080/00207390902971999

Sadi, A. (2007). Misconceptions in Numbers. *UGRU Journal, 5*(Fall), 1-7.

Salden, R. J. C. M., Aleven, V. A. W. M. M., Renkl, A., & Schwonke, R. (2009). Worked Examples and Tutored Problem Solving: Redundant or Synergistic Forms of Support? *Topics in Cognitive Science, 1*, 203-213. doi: 10.1111/j.1756-8765.2008.01011.x

Sanders, D. A., & Bergasa-Suso, J. (2010). Inferring Learning Style From the Way Students Interact With a Computer User Interfaces and the WWW. *IEEE Transactions on Education, 53*(4), 613-620.

Scheiter, K., Gerjets, P., & Schuh, J. (2010). The acquisition of problem-solving skills in mathematics: How animations can aid understanding of structural problem features and solution procedures. *Instructional Science, 38*(5), 487-502. doi: 10.1007/s11251-009-9114-9

Schoefegger, K., Seitlinger, P., & Ley, T. (2010). Towards a user model for personalized recommendations in work-integrated learning: A report on an experimental study with a collaborative tagging system. *Procedia Computer Science, 1*(2), 2829-2838. doi: http://dx.doi.org/10.1016/j.procs.2010.08.008

Schoeman, H. (2005). *The conative aspects of e-learning.* Master of Education in Computer Integrated Education, University of Pretoria.

Schoenfeld, A. (1985). *Mathematical problem solving.* Orlando: Academic Press.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 334-370). New York: Macmillan.

Sembiring, R. K., Hadi, S., & Dolk, M. (2008). Reforming mathematics learning in Indonesian classrooms through RME. *ZDM, 40*(6), 927-939. doi: 10.1007/s11858-008-0125-9

Serin, O. (2011). The effects of the computer-based instruction on the achievement and problem solving skills of the science and technology students. *TOJET, 10*(1), 183-201.

She, H.-C., & Fisher, D. (2003). Web-based E-learning Environments in Taiwan: The Impact of the Online Science Flash Program on Students' Learning. In M. S. Khine & D. Fisher (Eds.), *Technology-Rich Learning Environments: A future Perspective* (pp. 343-367). Singapore: World Scientific Publishing.

Shih, C.-C., & Gamon, J. A. (2002). Relationships among learning strategies, patterns, styles and achievement in Web-based courses. *Journal of Agricultural Education, 43*(4).

Shrader, V. E., Parent, S. B., & Breithaupt, D. L. (2005). *Factors for Success: Characteristics of Graduates in an Online Program.* Paper presented at the 3rd Annual Hawaii International Conference on Education, Honolulu, Hawaii. http://www.trainingplace.com/source/research/wgushrader.pdf

Sing, C. C., & Khine, M. S. (2006). An Analysis of Interaction and Participation Patterns in Online Community. *Educational Technology & Society, 9*(1), 250-261.

Smith, J. P. (1995). Competent reasoning with rational numbers. *Cognition and Instruction, 13*, 3-50.

Stein, D. S., & Wheaton, J. E. (2003). On-line Learning Communities and Higher Education: Factors Supporting Collaborative Knowledge-Building. Retrieved from http://www.rcet.org/research/ATT-OLN/Wheaton-Stein-Final.pdf

Sternberg, R. (2003). *Cognitive Psychology*. Wadsworth: Thomson.

Stipek, D. (2002). Good instruction is motivating. In A. Wigfield & J. S. Eccles (Eds.), *The development of achievement motivation* (pp. 310-334). New York: Academic Press.

Sun, J.-n., & Hsu, Y.-c. (2013). Effect of interactivity on learner perceptions in Web-based instruction. *Computers in Human Behavior, 29*, 171-184.

Swars, S. L., Daane, C. J., & Giesen, J. (2006). Mathematics anxiety and mathematics teacher efficacy: What is the relationship in elementary preservice teachers? *School Science and Mathematics, 106*(7), 306-315.

Sweller, J., & Cooper, G. A. (1985). The use of worked examples as a substitute for problem solving in learning algebra. *Cognition & Instruction, 2*(1), 59-89.

Tang, H.-H., & Kao, S.-A. (2005). *Understanding the User Model of the Elderly People While Using Mobile Phones*. Paper presented at the HCII '05, Ceasars Palace, Las Vegas, Nevada, USA.

Tasir, Z., Md Noor, N., Harun, J., & Ismail, N. S. (2008). A survey on online teaching preference among preservice teachers in Malaysia : Andragogy vs pedagogy *Hello! Where are you in the landscape of educational technology? Proceedings ascilite Melbourne 2008*. Melbourne.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53-55. doi: 10.5116/ijme.4dfb.8dfd

Taylor-powell, E. (1998). Questionnaire Design : Asking questions with a purpose. *System, (May)*. Retrieved from http://learningstore.uwex.edu/assets/pdfs/g3658-2.pdf

Thanasingam, S., & Soong, S. K. A. (2007). *Interaction patterns and knowledge construction using synchronous discussion forums and video to develop oral skills*. Paper presented at the Proceedings ascilite Singapore 2007, Singapore.

Thompson, M. M. (2008). *Individual Difference Theory and Research: Application to Multinational Coalition Teamwork*. Paper presented at the HFM-142 Symposium: Adaptability in Coalition Teamwork (NATO RTO-HFM-142). Pp KN2-1 - KN2-28.

Tirosh, D. (2000). Enhancing Prospective Teachers' Knowledge of Children's Conceptions: The Case of Division of Fractions. *Journal for Research in Mathematics Education, 31*(1), 5-25.

Tongco, M. D. C. (2007). Purposive Sampling as a Tool for Informant Selection. *Ethnobotany Research and Applications, 5*, 147-158.

Treffinger, D. J., & Selby, E. C. (2004). Problem Solving Style: A New Approach to Understanding and Using Individual Differences. *Korean Journal of Thinking & Problem Solving, 14*(1), 5-10.

Trinidad, S. (2003). Working with Technology-rich Learning Environments: Strategies for Success. In M. S. Khine & D. Fisher (Eds.), *Technology-Rich Learning Environments: A future Perspective* (pp. 97-113). Singapore: World Scientific Publishing.

Tripathi, P. N. (2009). *Problem Solving In Mathematics: A Tool for Cognitive Development*. Paper presented at the 3rd International conference to review research on Science, TEchnology and Mathematics Education, Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

Tucker, A. (2008). Fractions and units in everyday life. In B. L. Madison & L. A. Steen (Eds.), *Calculation vs. Context: Quantitative Literacy and Its Implications for Teacher Education* (pp. 75-86). Washington, DC: Mathematical Association of America.

Turner, J. C., Meyer, D. K., Midgley, C., & Patrick, H. (2003). Teacher discourse and sixth graders' reported affect and achievement behaviors in two high-mastery/high performance mathematics classroom. *The Elementary School Journal, 103*(4), 357-382.

Usiskin, Z. P. (2007). The future of fractions. *Arithmetic Teacher, 12*(7), 366-369.

Uusimaki, L., & Nason, R. (2004). *Causes underlying pre-service teachers' negative beliefs and anxieties about mathematics.* Paper presented at the Proceedings of the 28th Conference of the International.

van der Sluijs, K., & Houben, G.-J. (2005, July 25 -26). *Towards a Generic User Model Component.* Paper presented at the Personalization on the Semantic Web (PerSWeb'05), Edinburgh, UK.

Van Merrienboer, J. J. G., Kirschner, P. A., & Kester, L. (2003). Taking the load off a learner's mental mind: Instructional design for complex learning. *Educational Psychologist, 38*(1), 5-13.

Vat, K. H. (2009). Developing REALSpace: Discourse on a Student-Centered Creative knowledge environment for Virtual Communities of Learning. *International Journal of Virtual Communities and Social Networking, 1*(1), 43-74.

Vinson, B. M. (2001). A comparison of preservice teachers' mathematics anxiety before and after a methods class emphasizing manipulatives. *Early Childhood Education, 29*(2), 89-94.

Visscher-Voerman, I., & Gustafson, K. L. (2004). Paradigms in the Theory and Practice of Education and Training Design. *ETR&D, 52*(2), 69-89.

Wang, H.-C., Li, T.-Y., & Chang, C.-Y. (2005). *A User Modeling Framework for Exploring Creative Problem-Solving Ability.* Paper presented at the Proceedings of the 12th International Conference in Artificial Intelligence in Education, Amsterdam.

Wang, S.-K., & Yang, C. (2005). The Interface Design and the Usability Testing of a Fossilization Web-Based Learning Environment. *Journal of Science Education and Technology, 14*(3), 305-313.

Weber, K., Martin, M. M., & Cayanus, J. L. (2005). Student interest: A two-study re-examination of the concept. *Communication Quarterly, 53*(1), 71-86.

Wegerif, R. (2007). Technology, Education and Enlightenment *Dialogic Education and Technology: Expanding the Space of Learning* (Vol. 7, pp. 269-299): Springer US.

Werby, O. (2009). *Characteristics of a Successful Online Learning Experience; a Case Study of Internet-based, Adult, Cooperative, Creative Writing Group Project.* Paper presented at the World Conference on Educational

Multimedia, Hypermedia and Telecommunications 2009, Honolulu, HI, USA. http://www.editlib.org/p/31512

Whitenack, J. W., & Ellington, A. J. (2009). K-5 Mathematics Specialists' Teaching and Learning about Fractions. *The Journal of Mathematics and Science: Collaborative Explorations, 11*(2009), 109-126.

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology, 25*(1), 68-81.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25*, 68-81.

Wigfield, A., & Meece, J. L. (1988). Math Anxiety in Elementary and Secondary School Students. *Journal of Educational Psychology, 80*(2), 210-216.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications. *Review of Educational Research, 47*(1), 1-64.

Woodward, J., Beckmann, S., Driscoll, M., Franke, M., Herzig, P., Jitendra, A., Koedinger, K. R., & Ogbuehi, P. (2012). *Improving mathematical problem solving in grades 4 through 8: A practice guide (NCEE 2012-4055).* Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Woolf, B., Arroyo, I., Muldner, K., Burleson, W., Cooper, D., Dolan, R., & Christopherson, R. (2010). The Effect of Motivational Learning Companions on Low Achieving Students and Students with Disabilities. In V. Aleven, J. Kay & J. Mostow (Eds.), *Intelligent Tutoring Systems* (Vol. 6094, pp. 327-337): Springer Berlin Heidelberg.

Ya-Amphan, D. (2002). A Comparative Study on the Problem-Solving Skills in Mathematics of Secondary School Students in Thailand and Japan: A Case of Equation. *Tsukuba Journal of Educational Study in Mathematics, 21*.

Yilmaz-Soylu, & Akkoyunlu. (2002). The Effects of Learning Styles on Achievement in Different Learning Environment. Department of Computer Education and Instructional Technology. *Turkish Online Journal of Educational*.

Zentall, S. S., & Ferkis, M. A. (1993). Mathematical problem solving for youth with ADHD, with and without learning disabilities. *Learning Disability Quarterly*, 6-18.