

Personalized Design Model for Children with Reading Difficulties

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Abstract:

Over the last decade, there has been an ongoing interest in the changes of the way how children learn through the use of personalized learning tools. This is signified by a greater intensity of researches and massive development of learning products which claimed to be personalized learning tools. What is becoming apparent, however, is that when it comes to conceptual models of personalization, there is no consensus on how the conceptual model should be presented as a source of reference in the development of interface design. Therefore, by focusing on the slow learner as a target user and reading as the learning content, this paper attempts to conceptualize and develop a conceptual model called Personalized Reading for Slow Learner (ReadUneed) as a persistent artifact that describes the personalized interface model for children with reading difficulties. The ReadUneed model addresses the issue of the lack of personalization model that covers theory-driven strategies from a broad spectrum of disciplines, particularly the discipline of HCI, pedagogy and psychology. Through the discussion, we hope the development of ReadUneed will provide sufficient description of a real world problem domain and will contribute in addressing the use of this model to perform meaningful personalization

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1. Introduction

Over the last decade, there has been an ongoing interest in the changes of the way how children learn through the use of personalized learning tools. The personalization, a new paradigm in learning, has proven to be an excellent way of providing technological support to education. In

recent years, considerable effort has been devoted to research on personalization that support learner to learn effectively. This is signified by a greater intensity of research and massive development of learning product which claimed to be personalized learning tools. A number of studies conducted by Xu, Huang, Wang, & Heales, (2014a); Hazra Imran, Ting-Wen Chang, Quang Hoang

(2014);Reichelt, Kämmerer, Niegemann, & Zander, 2014); and Garrido, Morales, & Serina (2016) and have shown the effectiveness of personalization maximizing the learning process in order to achieve the optimum way of learning.

However, as transformation arises in education set up as a result in the use of personalization technologies, one thing that needs to be considered is on the way to emerge and apply sound pedagogical foundation when employing these technologies. The challenge on how to provide a learning experience tailored to each learner's needs in an extremely diverse and rich environment still poses a challenge. In addition, although there is no doubt that the personalization able to cater each learner needs, developing a foundation of personalization and embedding principles in design, theories and approach based on children individual psychology needs is quite a challenging task in adapting personalization technology. The concept of personalization describes in this paper is extended to be implemented for slow learner children with reading difficulties due to its potential to fulfill the reading needs of the slow learner. This initiative is taken to provide assistive mechanism for primary school in Malaysia to use personalized reading supplement for teaching and learning purposes. In an attempt to address these challenges, this study formulates a conceptual model that could offer a platform for integration pedagogy and personalization technology for slow learner children. The conceptual model developed covers all important aspects not only the personalization for content design and presentation design, but also focuses on modeling the conceptual design for developed user profile, and by considering adaptation of several relevant theories and principles related to motivational, reading theories, psychology and interface design are embedded to enrich the design. This work and its finding might be significant to designer and instructor who are dealing and designing slow learner interface design and also may provide useful insights for conducting further research in the area of personalized learning, learner engagement and other designs especially focusing on the area for children with special needs such as the slow learner.

2. Literature Review

Personalization technology promises great potential that enables a technology to work as a tool to be used by a user according to individual requirements, user needs (Gil, Giner, & Pelechano (2012) ; Rezaei, Heisenberg, & Heiden (2014) and learn according to each individual pace of learning (You, Li, Xiao, & Liu, 2019). In regard to the implementation of personalization in education, personalized learning is a term that frequently used by various academic scholars. Personalized learning in general refers to the learning approach that covers instruction that offers pedagogy, curriculum, and learning environments to meet the student's individual needs. Research in personalized learning hits education area due to the ability of personalization to overcome some specific limitation of traditional learning approaches. The personalization principle states that students learn better with a personalized approach than a nonpersonalized approach (Kühl & Zander, 2017). The increasing interest of the technology design practitioners and educators in personalization is due to the awareness that a 'one-size-fits-all' approach to education is inappropriate and not suitable to be implemented to reach individual needs in learning (Donoghue & O'Donoghue, 2010). Agreed with the issue on providing one material approach in education is no longer fits all, Bauml (2016) also added that the change requires in the area of providing specific instructional resources and specific content-based material for children. Although Bauml (2016) does not mention the word personalization specifically in this article, he did mention on the need to meet student's learning needs and providing adaptation materials based on children specific criteria. Recent studies, for instance, studies conducted by Martinez & Ph (2015); Nafea, Maglaras, S'iewe, Smith, & Janicke (2016b), Henze et al.(2017) and Cakula & Sedleniece (2013) has indicated that the increasing use of technology to support personalized learning is tremendous, however the use of technology in learning does not affect learning of the children with limited learning ability.

2.1 Review on Existing Personalization Models

The objective of this study is to conceptualized the personalization model of interface design for children with reading difficulties. The children with reading difficulties here refer to the slow learner children. In the process of developing the intended model, literature study of existing personalization models exist in the education are reviewed in order to perform analysis on the important elements of the model and how the personalization model are conducted. Provided here is the literature analysis on existing personalized model and framework in the area of personalization in education. The analysis on the literature in this study focuses on the coverage of several important dimensions in learning in the existing model developed, namely the personalization dimension, the learning dimension, the pedagogical dimension and the psychological dimension. Each dimension supports the personalization and children by providing useful information for the personalization of reading that has been developed. Table 1.0 demonstrates the matching of each particular studies with the dimension applied. From the analysis of the literature study, the finding indicates that there is a lack of the pedagogical and psychological aspect applied to the personalization in the area of learning, although massive studies conducted generate their own framework and model to specifies the overview of the personalization. The table below indicates several reviews on existing conceptual model and its elements explored by academic scholar in several areas in education field.

Table 1: Existing Personalization Model

Personalization model	Personalization Dimension	Learning Dimension	Pedagogical Dimension	Psychological Dimension	Framework/Model elements
Brusilovsky & Millán (2007)	√	√	√	√	√

and Thaker, Huang, Brusilovsky, & Daqing (2018)					
Brusilovsky (1996)	√	√	√	√	√
Brusilovsky & Eklund (1998)	√	√	√	×	√
Brusilovsky, Wade, & Conlan (2007)	√	√	√	×	√
Brusilovsky et al. (2007)	√	√	√	×	√
Xu, Huang, Wang, & Heales (2014)	√	√	√	×	√
Hazra Imran, Ting-Wen Chang, Quang Hoang (2014)	√	√	√	×	√
Patil (2014)	√	√	×	×	√
Saleena & Srivatsa (2015)	√	√	√	×	√
Brusilovsky (2016)	√	√	√	√	√
Garrido	√	√	×	×	√

Morales, & Serina (2016)					
Nafea, Maglaras, Siewe, Smith, & Janicke (2016)	√	√	√	×	√
Constantinides & Dowell (2016)	√	√	×	×	×
Hsiao & Brusilovskiy (2017)	√	√	√	×	√
Aroyo et al. (2017)	√	√	√	×	√
Pelánek (2017)	√	√	√	×	√
C. Chen (2017)	√	×	×	×	√
Adesuyi, Obolo, Oloja, & Badeji-Ajisafe (2018)	√	√	√	×	√
Peng, Ma, & Spector (2019)	√	√	√	×	√
This Study	√	√	√	√	√

Comparison of personalized models and their system implementation considerations:
(√ Yes; × No, Û; Unknown)

2.2 Discussion on the Existing Personalization Models

Personalization technologies promise a great potential to enhance children learning. However, as transformation arises in education set up as a result in the use of personalization technologies, one thing needs to be considered is on the way to emerge and apply sound pedagogical foundation when employing these technologies. It is still challenging to provide a learning experience tailored to each learner's needs in an extremely diverse and rich environment. In addition, although there is no doubt that the personalization able to cater each learner needs, developing a foundation of personalization and embedding principles in design, theories and approach based on children individual psychology needs is quite a challenging task in adapting personalization technology. Personalization also requires some underlying technologies, principles and theories to be adapted to support individual differences. Kucirkova (2018), Professor of Early Childhood Education and Development at the University of Stavanger, Norway in her comprehensive study of the personalization has claimed that there is no framework specifically supports various areas related to personalization. She also addresses that there is a significant research gap to establish new framework of personalization. In addition, Dumitrache & Dumitraşcu (2014) and Bartolomé, Castañeda, & Adell (2018), mutually agreed that the existing intervention to solve issues related to the teaching and learning process usually either unresolved or disconnected. Also, various studies conducted that proposed personalization framework as a solution for children reading also argues on the lack of pedagogical approaches (Bartolomé et al., 2018), relationship of teacher and student and providing teaching and learning content (Dumitrache & Dumitraşcu, 2014). Moreover, Glushkova (2015) and Ismail, Harous, & Belkhouche (2016) have mentioned that the implementation of personalization requires in-depth coverage of pedagogical approach embedded in the application. However, although all the mentioned authors have addressed the important of providing a broad spectrum in the personalization framework, there is a lack of the source of reference covering of all HCI, education

and psychological disciplines in designing reading material for children with reading difficulties. In an attempt to address these challenges, this study formulates a conceptual model. The conceptual model developed covers all important aspects not only the personalization for content design and presentation design, but also includes the reading model, user model, adaptation model and application as a basis for development of personalized interface design for children with reading difficulties, that is the slow learner. In order to achieve the comprehensive conceptual model then, the user engagement through motivational theory and reading theory are also embedded to enrich the design. The model developed maybe significant to designer and instructor who are dealing and designing slow learner interface design. This work and its finding may provide useful insights for conducting further research in the area of personalized learning, learner engagement and other design especially focusing on the area for children with special needs such as the slow learner.

3. Development of the Personalized Reading for Slow Learner (ReadUneed) Conceptual Model

This study focuses on the way to provide personalization in reading for slow learner children who are having difficulties in reading. Presented here are several considerations and approaches to develop the conceptual model of ReadUneed.

3.1 Identify General Concepts from Literature

In personalizing reading material, we have looked on several important concepts in personalization by performing an analysis of the key elements related to the personalization model. Table 1.0 depicts an overview of several elements adapted in the development of the personalized working model.

Table 2.0 Comparison of personalized models and their elements

Personalization model	Types of Learner	Elements
(Brusilovsky & Millán, 2007), (Thaker et al., 2018)	General learner	User model Adaptation model
(Brusilovsky & Eklund, 1998)	General learner	User model
(Brusilovsky et al., 2007)	General learner	Adaptation model
(Brusilovsky et al., 2007)	General learner	User profile, adaptive selection
(Brusilovsky, 1996)	Elearning user	User model: knowledge, goal, background and experience, preferences
(Brusilovsky, 2016)	Elearning user	Domain modeling for user and content modeling
(Thaker et al., 2018) Also Brusilovsky	Reader	Knowledge model for reading textbook
(Hsiao & Brusilovsky, 2017)	General learner	User model Adaptation model
(Xu et al., 2014b)	University students	User Model+ profile, curriculum model, dynamic model, static model learner modeling, learner agent
Saleena & Srivatsa (2015)	General user	User Scalar Model, User Interest Model, User Profile Model, Learning Object, Ontology
(Hazra Imran, Ting-Wen Chang, Quang Hoang, 2014)	Ū	Learner model Adaptive recommendation model
(Patil, 2014)	Internet User	User profile Ontology

		modelling
(Garrido et al., 2016)	School, high school, university student	authoring tool, teacher, student, Database, LMS
(Peng et al., 2019)	Smart device user	individual characteristics, individual performance, personal development, and adaptive adjustment
Aroyo et al. (2017) * refer Brusilovsky (2003)	Web user	Adaptation Model, Instruction Model, Domain Model, Context Model, User Model
Pelánek (2017)	General learner	Learner model (knowledge model, domain model), open learner model, interaction
Adesuyi, Obolo, Oloja, & Badeji-Ajisafe (2018)	Elearning user	Application model, domain model, user model, interface (Learning path, learning concept user
(Nafea et al., 2016)	Elearning student	student profile, behavior pattern adaptation engine reference ontology
(Constantinides & Dowell, 2016)	General reader	News reading apps for reader

3.2 Formulate general schemes

In order to come out with a comprehensive description of the model, the first steps before construction on the conceptual model is by identifying general schemes of the study. There

are three (3) important concepts identified in personalizing reading for slow learner children; personalization in reading, slow learner profiles and interface design. Other than that, the conceptual model developed also consider to embed the psychological theories and pedagogical approach in the implementation of the personalization of reading material developed as a supporting mechanism. Provide here are several identified schemes for development of conceptual model for personalized reading.

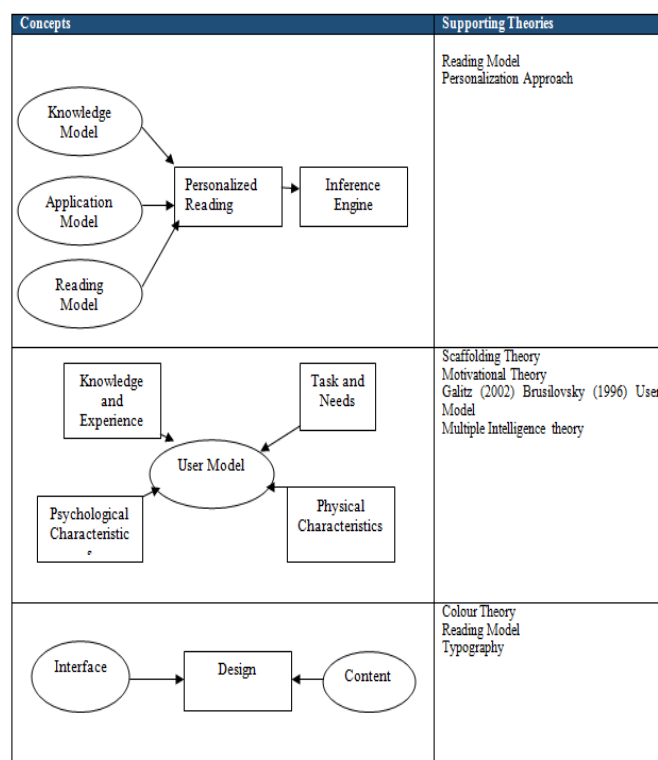


Figure 1: Formulation of General Schemes for Personalized Reading Model

3.3 Develop logical constructs for Personalization of Reading

This step is where the Conceptual Model of Personalization of Reading is developed. The arrangement and direction of the models are being made in order to ensure that the aim for the personalization is achieved and a comprehensive model that able to provide a mapped of solution design for slow learner children to cater their reading ability is accomplished. In this step, the mapping of user profiles, approach, theories and principle are

performed in order to guide personalization of content and presentation of reading material for slow learner children.

4.0 Personalized Reading for Slow Learner (ReadUneed) Conceptual Model

Designing a suitable and effective book requires the developer to follow the design methodology in order to ensure the design adapt principles set by the experts in the design area. The need for designing a new reading material which meets the criteria set by the design principles as well as considering the need of an individual user is found to be beneficial in the technological area. Meanwhile, personalization of reading activity that considers the variation of reader characteristics is able to generate new knowledge in the readers' mind faster than the traditional reading materials which can be considered as one-size-fits-all approach. Personalized Reading for Slow Learner (ReadUneed) Conceptual Model, aims at providing personalized reading content and personalized interface design for slow learner children with reading difficulties. By providing these two types of personalization that consider slow learner profile in design, it will provide the benefit for the slow learner children to learn reading using more efficient approach. In general, ReadUneed model main aim at providing slow learner children with the supportive reading tool suit with the slow learner reading ability and allow assistive use of reading material that encourages own learning, understanding slow learner psychological needs in term of motivation and provide scaffolds. Other than that, personalization tool using ReadUneed model also consider slow learner preference with theories and principle are adapted in the development of the conceptual model for better design of personalized reading material for slow learner children.

Development of Personalized Conceptual Design Model requires not only personalized technological approach but also adaptation of theories and principles. All this information is taking into consideration to developed better

design. Conceptual model develop is useful to be used in building reading material due to the comprehensive information covers from the personalization perspectives, reading model, psychological theory of motivation and learning theory. ReadUneed model aims to integrate development of personalized reading tool that carefully designed to be used by the slow learner children with reading difficulties. ReadUneed also considers slow learner limited reading capability in the design while providing personalized preferences and the slow learner needs.

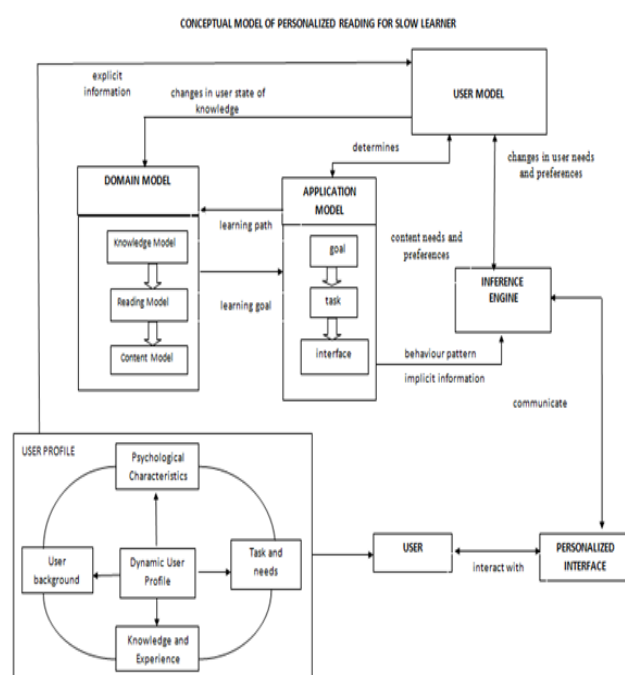


Figure 2: Conceptual Model for Personalization Reading for Slow Learner Children (ReadUneed)

Basically, the conceptual model for personalized reading comprises of the combination of several theories, strategy and approach as presented in the above figure which form an important elements in the design. These theories, approach and strategy have been chosen by taking several considerations. There are several important models that have been identified compulsory to be included in the (ReadUneed).

i) **Domain Models:** Domain Models are divided into three (3) models; Knowledge Model, Reading Model and Content Model. The knowledge model refers to the existing and changes of user state of knowledge related to the reading. The changes to the knowledge model then will continuously mapped in order to identify which reading model suitable to be assigned to the particular user. The reading model here is divided into three categories according to the ability of the slow learner to read; the orthography (word recognition), phonology (word decoding) and semantic (meaning) based on each slow learner performance in LINUS test result. The last model in the domain model, the content model is related to the representation of the book content suitable to the children which consists of several categories: Picture book, Early Reading Book and Storybook.

ii) **Application Model:** Consist of information on suitable goal, task related to reading and suitable interface for the slow learner children. The application also contains suitable information that is mapped with the ARCS Motivational Theory in which it is important in order to assist the slow children in reading as well as motivate the children in the entire reading activity.

iii) **Adaptation Model:** Contain information of implicit information related to preference and behavioral pattern of the user performing reading task. This information is important to determine the nature of behavior of the user to be used as reference in identification of suitable personalized interface and content for the slow learner reading for the next reading session.

iv) **Personalized Interface:** The interface that is useful for the user for reading. The information on the interaction with the personalized interface reflects the user interface on the second visit based on user information needs and preferences.

CONCLUSION

The conceptual model discusses in this study is hoped to be able to cater a broad picture on the need to provide specific guidelines for us to understand the uniqueness of slow learner children and to provide a suitable personalized reading tool for them. By doing so, it will ensure that the material use for teaching and learning suits the capability of slow learner children as an alternative for one-size-fits-all approach as implemented in the real classroom setting. Another possibility is that by providing a reading material as an extra alternative reading tool perhaps will be able to cater slow learner problems in relation to reading difficulties as reading is a gateway to future success in school and in life (National Institute for Literacy, 2007). Again, the designing aspect of user interface of reading material presented in this paper is a part of the study which concerns on the personalization aspects that might be useful in helping slow learner children read better as it provides the solution based on the individual need of each young children.

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