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"Strategizing IR4.0 in Conquering Covid-19 and Beyond"

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Preface

This e-book describes the research papers presented at the International Conference on Emerging Computational Technologies (ICECoT 2021), organised by Faculty of Computer and Mathematical Sciences (FSKM), UiTM Cawangan Melaka. The main discussions of the conference is on the technological advances that help shape the skills that are required to cope with the Fourth Industrial Revolution (IR 4.0). Considering that this is our first attempt at organising a conference, we are therefore greatly honoured that the Universitas Negeri Semarang (UNNES), Indonesia, Mahasarakham University (MSU), Thailand and University of Hail (UoH), Saudi Arabia have all agreed to become our partners by contributing several reseach papers as well as providing reviewers to assess the quality of the papers.

Out of the numerous research works that had been submitted and reviewed, the Editorial Board have selected 22 papers to be published in the e-book. The discussions of these papers pertain to the use of technologies within the broad spectrum of Computer Science, Computer Networking, Multimedia, Information Systems Engineering, Mathematical Sciences and Educational Technology. It is hoped that the research findings that are shared in this e-book can benefit those who are interested in the various areas of computational technologies; such as graduate students, researchers, academicians and the industrial players, to name a few.

As the Project Manager, I would like to thank all of the committee members from the bottom of my heart for their tireless efforts in ensuring the success of ICECoT 2021. Without their continual support and excellent teamwork, this conference would not have come to fruition. In fact, holding this major event has been a good learning experience for us all, and I sincerely believe that our future conferences will become more outstanding if the same spirit is maintained.

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Design and Development of *i-Dietkids* Courseware for Hearing Impaired Children Guided by Courseware Engineering Methodology

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***Abstract*—Designing and developing a multimedia courseware requires a structured approach and many novices are not aware of this. This paper discusses on the design and development of *i-DietKids* courseware which is guided by the Courseware Engineering Methodology (CEM). CEM is a model-based approach that has been applied mainly to aid those who are new to courseware design and development. The CEM process consists of four models; first, the pedagogical model that is related to the pedagogical features of the courseware. Second, the conceptual model that deals with the software engineering features of the design; third, the interface model that relates to the interface of the courseware, and finally the hypermedia model that deals with the navigational concerns of the courseware. Every model deal with the various aspects of the development process. Usability testing was conducted on the *i-DietKids* courseware, and the result has shown a very promising and feasible consumption in the educational setting. It is hoped that this *i-DietKids* courseware will be used to continuously educate hearing impaired children on the importance of nutritious food intake.**

Keywords—courseware engineering methodology, hearing impaired children, multimedia, nutrition education

I. INTRODUCTION

Good nutrition is important for children' health. Yet, educating children on nutritious food intake is a challenging task to educators especially in situations where educators are dealing with special needs children such as hearing impaired children. One of the issues is these children are picky eaters which is a common behavior among children. Picky eating refers to a situation where one is unwilling to consume some foods and has intense food preferences [1]. Consequently this picky eating habit may lead to inadequate dietary variety and a possible deficiencies of nutrient intakes such as low iron, zinc and fiber may compromise health [2]. These nutrient deficiencies are linked to low intake of fruit and vegetables.

Undoubtedly, these picky eating habits and food refusal behaviors are of concern for many teachers and parents. Many parents and teachers work with great effort to educate their children on healthy eating behaviors since they are concern with the possible lack of nutritional needs in the children' diet [3]. These efforts to improve healthy food consumption can create stressful situation at mealtime [4]. Undeniably, knowledge and understanding of children about nutrition is still lacking and the behavioral patterns established during childhood are often carried over into adulthood [5]. If the picky eating habits and food refusal behaviors still remain with the children, they may exhibit problems with growth that could probably lead to other health issues such as overweight and obesity [6]. Thus, integrating nutrition subjects in the elementary school programs may encourage the development of healthy eating habit among children [7]. Well-planned nutritional intervention programs can significantly give impact on the nutrition knowledge and improve the dietary habits of children [8]. For some children with special needs, improved nutrition is the factor most critical for survival [9].

Our case study supports the previously mentioned scenario. During our initial investigation phase, we conducted a series of interviews with teachers from Sekolah Kebangsaan Pendidikan Khas Kuala Terengganu (SKPKKT). SKPKKT is one of the schools in Terengganu that aims to provide education for children with hearing impaired. During their stay at the school, these children are given meals that comply with the menu as directed by the Ministry of Education. School menus offer milk, whole grains, fruit, vegetables and vital nutrients as guided by the food pyramid [10].

From the interviews, several issues were identified. First, SKPKKT has a lack of control on food waste. Fruits and vegetables are wasted every day since the children do not eat them. Second, the teachers are lacking of teaching aids on nutrition education for children with hearing impaired. Currently the teachers are still using textbooks and a limited number of videos for references. Third, current resources are lacking of sign language provision. Due to this, the children are not able to focus in class and this may lead them to losing interest in the lesson taught by the teacher.

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Therefore, to avoid the food leftovers and help teachers to expose the awareness of healthy eating among hearing impaired children, a nutrition education courseware should be made available. To develop the *i-DietKids* courseware, the authors have chosen a Courseware Engineering Methodology that adopts the fundamentals of instructional design and learning theories [11]. Courseware design and development is a complicated task and it is impractical for designers to handle all the requirements at once. In particular, the initial design and ultimate implementation are critical to successfully delivery the outcome to the targeted user [12]. Therefore, a structured and documented approach is needed that provides a clear roadmap for courseware development work.

II. Related Works

This section elaborates related works to this study within the following contexts.

A. Nutrition Education

The aim of nutrition education is to develop healthy eating habits and improve nutrition knowledge among school children [13]. However, nutrition education is considered one of the difficult subjects to teach to children [14]. In particular, fruits and vegetables are known to be poorly accepted and under consumed among children [15]. Nutrition deficiency or malnutrition is also common among children with special health care needs. For special needs children such as hearing impaired children, a study reported that the food refusal rate was significantly higher compared to the normal group where no fruits and vegetables were taken at all during the three-days study [16]. Yet, these children understand that they need to consume a healthy food in order to be healthy [17].

Therefore, children with hearing impairment require specially developed nutrition education materials and programs that can be understood quickly and easily [18] supported with food models and demonstrations in order to assist teaching and learning. Improving the nutritional knowledge for these children may increase both the level of independence towards a healthier food intake and the quality of life [19]. Making decision on a healthier diet is an independent skill and teaching the skill can be effectively done through video modeling as instructional method [20]. In addition, visualized nutrition education on dietary knowledge is considered promising in improving dietary behaviors [21].

B. Hearing Impaired Children and Sign language

Hearing impairment is defined as partial or total inability to hear. Children with hearing impairment learns greatly by observation [22]. The major challenge facing students with hearing impairments is communication. This is a known fact as hearing-impaired children vary widely in their communication skills. The gap is due to the differences in personality, intelligence, nature and degree of deafness, amount and type of residual hearing, extent of benefit derived from amplification by hearing aid, family environment, and age of onset of impairment [23]. Therefore, hearing impaired children require support in these four areas i.e. communication and interaction, cognition and learning, behavioral, emotional and social development, and sensory or physical aspect of development.

Hearing impaired children use sign language as a primary means of communicating [24]. While there is a single sign for a particular food, the sign must be finger spelled and lack of vocabulary among children hinders spelling. As hearing impaired children can benefit from game-based activities, visual support game-based learning should be considered to boost their motivation in learning new concept [25].

C. The Use of ICT

To enhance teaching and learning for children with special needs, various technologies have been brought into the classroom such as 3D games, Deaf Talk sign language interpreter and translator [26], Sign Language Avatar [27], Augmented Reality [28] and Virtual Reality [29]. For example, technological advancement has been used greatly to enhance literacy and linguistic ability for individuals with disabilities [30].

Interventions using computers, ICTs, multimedia and technology have proven effective in enhancing learning among hearing impaired children [31]. The use of these technologies allows learners with disabilities to have control over the learning process and learning preferences. In particular, the use of computer-based games can also motivate and engage students in the classroom [32]. Children become familiar with foods through repeated exposure, which is perhaps the most critical aspect of learning [15]. The use of social influences such as cartoon characters is another important aspect during the learning process. It was reported that kids demonstrate attention in obtaining dietary material through digital gameplay [33]. Thus, a computerized game that emphasizes on dietary education could act as a promising instructional tool for promoting healthier food intake among children.

D. Pedagogy

In educating these hearing impaired children, the real challenge is not due to the lack of cognitive abilities among these children, but with the scarcity of the educational approaches in educating them [34]. In designing a courseware with multimedia instruction, Mayer [35] insisted that developers adopt the science of learning and the science of instruction when presenting the content. According to Mayer, learning depends on the learner's cognitive processing during learning and includes (a) selecting: attending to the relevant incoming material; (b) organizing: organizing the incoming material into a coherent mental representation; and (c) integrating: relating the incoming material with existing knowledge from long-term memory.

In designing computer-based learning for hearing impaired children, it is necessary to consider their needs and learning style [36]. Often, their needs have been overlooked in the design. For learning to be effective, the courseware must be designed carefully and it must be appropriate for learners [37]. Consequently, these concepts can be used effectively for learners with special needs [38].

E. Design Model

Most courseware development works adopt the generic ADDIE model (Analysis, Design, Development, Implementation and Evaluation) [39]. For example, a courseware development work on nutrition topic was carried out using ADDIE model [14] incorporating Problem-Based Learning approach. Traditionally, waterfall-based model has been used widely for designing innovative health-related products for hearing impaired children [40]. Particularly for projects that involve designing an application for speech and language training, a user-centric approach is required.

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III. COURSEWARE ENGINEERING METHODOLOGY

Courseware Engineering Methodology is based on design principles and guidelines to assist designers and novices in the courseware development process [11]. Fig. 1 shows the framework of CEM process.

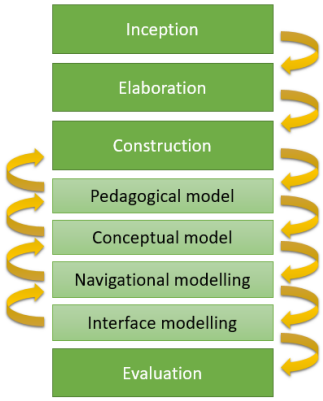

Fig. 1. Courseware Engineering Methodology

There are four phases in Courseware Engineering Methodology i.e. inception, elaborations, construction and deployment as tabulated in Table I. Each process is discussed in the following section.

TABLE I. OVERVIEW OF COURSEWARE INTERFACE DESIGN PROCESS

Phase	Activity	Outcome
Inception	Conduct an interview to identify the problem that faced by the teachers in explaining about the important of healthy food Identify the user requirement of the proposed courseware Identify the scope of the proposed courseware	Problem statement User requirement Scope
Elaboration	Design Use case modeling Learner analysis	Use case
Construction	Pedagogical model Conceptual model Navigational modeling Interface modeling – Visual-spatial intelligence	Conceptual process Conceptual model Storyboard Site map Evaluation form
Evaluation	Students' performance Lesson effectiveness User functionality and usability	

A. Inception

Through the inception phase, the justification and scope of the task are identified. The inception phase includes the review of options and planning. The essential part of the inception phase is the conceptualization process. Conceptualization is the process of brainstorming for a courseware together with a concept of its requirements and form. In this process, it determines the high-level outline and structure, based on the organizational needs and the available technology. In this phase, the authors met with the teachers at SKPKKT in order to learn their needs.

B. Elaboration

During elaboration phase, detailed requirements were collected and analyzed. The use case modeling has been designed to improve understanding of requirements. The use case modeling in Courseware Engineering Methodology aids in the following aspects of courseware development: capturing requirements, planning iterations of development and validating systems [11]. This phase describes how people collaborate with a system and work towards some goals. Two users were identified in the courseware i.e. hearing impaired student and the teacher as shown in Fig. 2.

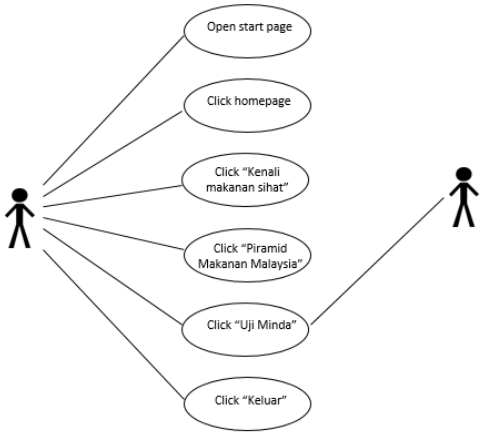

Fig. 2. Use Case Modeling.

C. Construction

Under Construction phase, there are four sub-phases i.e. Pedagogical model, Conceptual model, Navigational modeling and Interface modeling. Each model deals with the various aspects of the development process. The Construction phase involves many iterations where a single iteration shapes production quality courseware, verified and unified that satisfies the system requirements [11]. All iterations contain the standard life cycle i.e. analysis, design, development, testing and evaluation which form the micro process level of the Courseware Engineering Methodology activities.

1) Pedagogical Model

During the construction phase, a Pedagogical model is produced. The pedagogical model is important since the lack of pedagogy in courseware can lead to its rejection by learners [41]. It is therefore crucial that pedagogy is a main concern in courseware development. Under the Pedagogical model, several activities took place that defines clearly these aspect i.e. objective, assessment and pedagogical strategies. The objective definition explains the learning outcomes of the intended courseware. After the objectives have been defined, the developers then determine the optimum sequence of the instruction.

2) Conceptual Model

The Pedagogical model built earlier must be translated into concepts and notions that are suitable. Fig. 3 shows the conceptual model for the proposed courseware. This courseware will use four important theories to develop the courseware which are Cognitive Theory Multimedia Learning by Mayer, Multiple Intelligence, Nutrition Education and Courseware Engineering Methodology.

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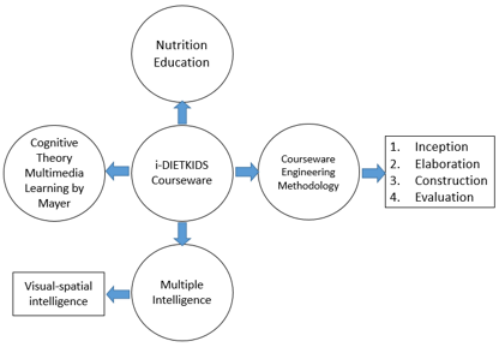

Fig. 3. A conceptual model for *i-DietKids* courseware

3) Navigational Modeling

Navigational modeling is the third step of the development process. In CEM, the navigational model is built over a conceptual model, thus allowing the construction of different models according to different users' profiles. Fig. 4 shows the handwritten navigational map of the proposed courseware. There are three modules in the proposed courseware which are "*Kenali Makanan Sihat*", "*Piramid Makanan Malaysia*" and "*Uji Minda*". "*Uji Minda*" is the module that contains quiz-based activities.

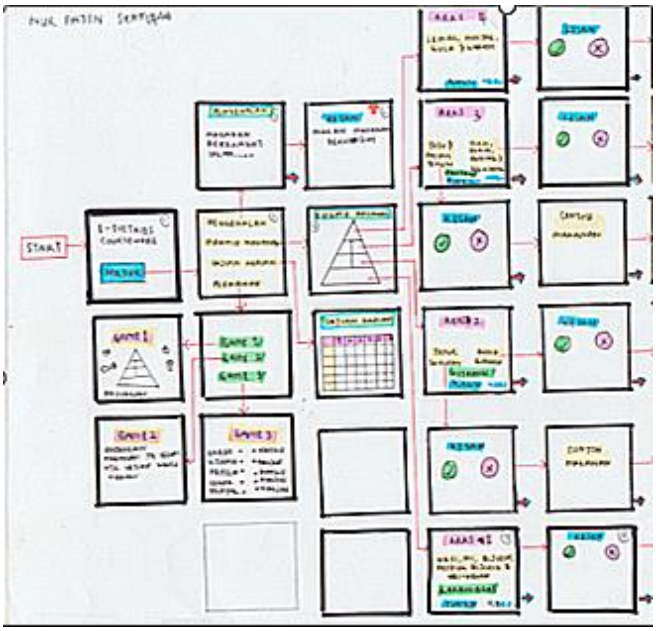

Fig. 4. A handwritten navigational map for *i-DietKids* courseware

4) Interface Modeling

The last step of the development process is the interface modeling. In this work, the authors had used storyboarding as an interface modeling for the courseware. The storyboard for each page was produced to demonstrate all the elements that will be considered into the page including the multimedia elements and navigational buttons. Fig. 5 shows the storyboard that should be on the page of "*Piramid Makanan Malaysia*" with its content structure.

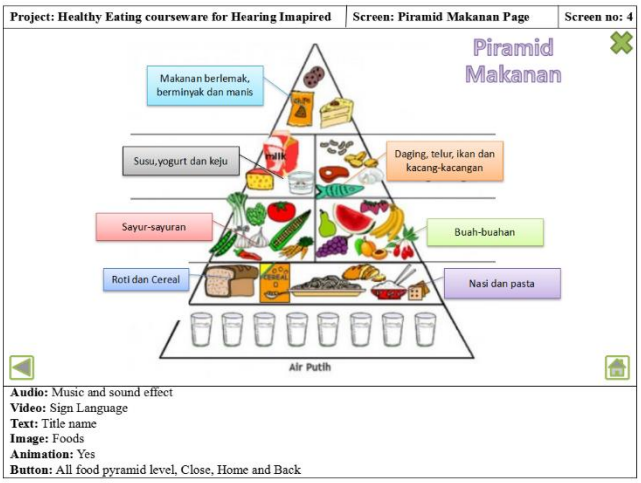

Fig. 5. Storyboard for *i-DietKids* courseware

D. Evaluation

The final step in the construction phase of Courseware Engineering Methodology is evaluation. In this work, lessons were assessed for their general quality, their applicability and usability. Table II shows the questionnaires used in evaluating the usability aspect of this *i-DietKids* courseware.

TABLE II. EVALUATION ON USABILITY

Construct	Items
A: Text	A1: Easy to read texts.
	A2: Fonts are suitable.
	A3: Clear text layout.
	A4: Information positions are standardized.
	A5: Easy to understand the text explanation.
B: Graphic	B1: Colors used are attractive.
	B2: Graphics are clear.
	B3: Graphic used are suitable.
	B4: Explanation using graphics are easy to understand.
C: Content	C1: The content of this courseware is suitable.
	C2: The content of this courseware is definite and understandable to learn.
	C3: This courseware delivers important information.
	C4: The content of the courseware can improve my knowledge in healthy food.
	C5: Topics included in this courseware are interesting.
D: Animation	D1: The animations used in the explanation are helpful to understand the topic.
	D2: The animations elements used are suitable to explain the topic.
	D3: The animations are attractive.
	D4: The animation helps to visualize the flow of topic
E: Interactivity	E1: Interactivity tool are easy to use.
	E2: Navigations are easy.
	E3: The links used are correct.
	E4: Buttons used are standardized.
F: Navigability	F1: Menu key to return to the main page
	F2: Exit key to exit from the courseware
	F3: Key for moving forward or backward in a lesson
	F4: Key for accessing the next lesson in a sequence

IV. RESULTS AND DISCUSSION

The *i-DietKids* courseware was successfully developed by applying the guidelines in the Courseware Engineering Methodology. The core content modules in this *i-DietKids* courseware are "*Kenali Makanan Sihat*", "*Piramid Makanan*" and "*Uji Minda*" as shown in Fig. 6.

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Fig. 6. Content modules of *i-DietKids* courseware

The usability evaluation has been carried out by thirty respondents aged between 11 to 30 years old based on the questionnaires in Table II. The respondents included lecturers and students of UiTM's Kuala Terengganu Campus, as well as teachers and students at Sekolah Kebangsaan Pendidikan Khas Kuala Terengganu.

This paper reports only the usability aspect of Content construct of the questionnaires. The responses follow Likert Scale's rating that ranges from 1 to 5; 1 for strongly disagree, 2 for disagree, 3 for neutral, 4 for agree and 5 for strongly agree. The overall result on the content construct tabulated with mode, mean and standard deviation (SD) is shown in Table III below.

TABLE III. CONTENT CONSTRUCT

No.	Statement	Mode	Mean	SD
C1	The content of this courseware is suitable	4	3.97	0.67
C2	The content of this courseware is definite and understandable to learn	4	3.97	0.67
C3	This courseware delivers important information	4	3.8	0.67
C4	The content of this courseware can improve my knowledge in healthy food	4	4	0.69

From the result, most respondents agreed that the content of *i-DietKids* courseware is suitable, understandable, delivers important information and improves one's knowledge in healthy food. The dispersion of standard deviation is also small (< 1) which implies that the data are clustered around the mean, making the result more reliable. In other words, there is a small difference in satisfactory level for the content of the *i-DietKids* courseware.

V. CONCLUSION

A proper dietary intake results in greater cognitive and motor level, social development, educational attainment, productivity and lifetime earnings; thus intensive efforts is required to provide a practical and complete nutrition education. We have presented a Courseware Engineering Methodology adopted in the design and development of i-DietKids courseware. The i-DietKids courseware focuses on the nutrition education for hearing impaired children. The use of videos and visual sign language assist hearing impaired children to understand the nutrition materials better. With good knowledge on nutritious food intake, children are expected to improve their nutritional habits; thus leading to a healthier lifestyle. Future works should investigate into the possibility of assessing both eating behaviors and emergence of related diseases or psychosocial concern among these children.

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