A LEARNING CYCLE MODEL IN EDUCATION FOR SUSTAINABLE DEVELOPMENT

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BSTRACT

A LEARNING CYCLE MODEL IN EDUCATION FOR SUSTAINABLE DEVELOPMENT

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One of the goals of the educational design research is to overcome the limitations of the educational systems. ICT provided innovative solutions and models for better learning environment in urban society. However the benefits of ICT models are not fully applied in developing local education for sustainable development.

The main purpose of this study was to investigate the effect of adopting the sustainable learning cycle model-enhanced peer educator approach in a meaningful learning environment. In this study a new 6E learning cycle model, as a type of project-based learning, was presented in three main phases; Form, Inform, and Reform (FIR). Action research (which includes both quantitative and qualitative experimental studies) was conducted over two semesters 2013 and 2014 to transfer student's attitudes from learner to peer-educator in a longitudinal learning environment.

For the comparison, two case studies were carried out in an elementary school in Kitami city of Japan. In the first case study, 30 random students as the control group were

exposed to cross-cultural lesson based on the conventional instructional style. In the second case study, same students as an experimental group were to engage in creating DVD learning materials for international rural students in Egypt with the 6E learning cycle style under the teacher's positive involvement.

The experimental and control group were evaluated by both descriptive and statistical analyses. In addition, post and semi-structured observation and interviews were conducted to evaluate the validity and reliability of the methodology. In terms of learning skills especially, FIR-6E instructional model students showed not only better results in developing education for sustainable development, but also improved students' self-regulation and critical thinking skills than those were taught using the conventional constructional style.

Keywords: ICT- Educational Design Research, Learning Cycle model, Self-regulation Skills, Critical-thinking Skills, Education for Sustainable Development

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Working for more than 15 years in teaching and research fields allowed me to witness the rapid change in teaching methods with the effective use of ICT in education filed in Japan. FIR/6E learning cycle as a new learning environment design, is a way to support and develop not only learning approach but also students 'conceptual skills in education for sustainable development (ESD).

My interest in merging the FIR/6E instructional model into local education for sustainable development began at the University of Heidelberg of USA where I was a student of Professor Jerrold Frank. During this time I completed my master's thesis on the relationship between cross-culture digital activities and student motivation in studying foreign language; sister school-based project. Professor Frank was a great supporter in developing my cross-culture collaborative study and finishing an effective academic MA thesis. I would like to thank Professor Frank for his encouragement and support.

In order to develop the effective use of design of development research into education for sustainable development in rural area in Egypt, I had a great chance to develop my research of using ICT in ESD at Kitami Institute of Technology. The idea of adopting ICT tools and model in ESD was nominated special award from the Japan Prize International Education and Media contest and the International ESD conference in Nagoya 2014. I would like to address a special thank to my supervisor, Professor Eisaka TOSHIO for his high standards, careful edits, encouragement, support and insights. His extraordinary ability of supporting me with required

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LIST OF SYMBOLS

ICT……..: Information and Communication Technology

FIR ……..: Form, Inform & Reform phases

ESD……: Education for Sustainable Development

DESD…….: Decade of Education for sustainable development

EDR …….: Educational design research

IDT ……...: Instructional design technology

ISD …….: Instructional systems development

TBLE …….:Technology-based learning environment

IBSTPI…….:International board of standards for training, performance, and instruction

ADDIE……..: Analysis, design, development, implementation, and evaluation

NSES ……..: National science education standards

CTM …….: Cognitive trait model

5E ……: Engagement, exploration, explanation, elaboration, and evaluation

6E …….: Experience, explore, explicate, elaborate, evaluate and extend

CHAPTER 1

INTRODUCTION

In the realm of Education for sustainable development, United Nations Educational, Science and Cultural Organization (UNESCO) investigated the major problems in education; 1) the lack number of teachers and qualification, and 2) the lack of appropriate sustainable instructional tool, which focus on competencies of integrating educational technology into teaching (DSED 2005-2014). The ICT, as an educational design research, hopefully contributed in developing scientific solutions in modern societies. Such solutions fail to reach the mass in rural area in the developing countries. Also the gab in education environment between the urban and rural community leaded to high rate of literacy in rural areas. Such gab needs more scientific research to investigate on the way to adopt an appropriate ICT model that links both communities in a meaningful learning environment.

In the current climate of education, a significant body of research has called attention to the need of enhancing students' meaningful and active environment through integrating instructional technology into learning as a educational design research (EDR). The EDR can overcome the limitations in the educational systems such as transform learning environments to address higher order of thinking skills, teach advanced concepts (Christensen, 2002; Guzman & Nussbaum, 2009), and develop self-regulation skills (Zimmerman, 2000; Järvelä, Järvnoja and Veermans, 2007; Pintrich, 2000; Dignath et al.,

2008). Thus, adopting ICT instructional model-enhanced learning cycle environment is an empirical process that presents the effectiveness of the proposed instructional mode's use in a real-world sustainable situation.

Within this setting the way in which teachers apply ICT instructional models in enhancing learning and skills are being challenged. In the term of learning activities, teachers strive to provide a meaningful learning which focus on developing students' conceptual skills such as self-regulation and critical thinking. Many researchers found that self-regulation has positive effect on elementary school students' learning outcomes (Dignath et al., 2008) and motivation (Cleary & Zimmerman, 2004; Pintrich & Schunk, 2002). Recently, the research in self-regulation has increased to integrate an appropriate learning model into lesson plans and curriculum development demands including students' motivation (Weimer, 2002) and developing their meaningful learning environment (Project Kaleidoscope, 2006).

Another critical issue is how to design an effective learning model using integrated technology to assist teacher's lesson plan and authentic materials. Thus, a validated instructional model would have an impact on both teachers' teaching and students' active learning environment. In which students would assume responsibility for both identifying and monitoring individual learning goals, select means to support their learning (Michael J. Hannafin, Janette R.Hill, Susan M. Land, and Eunbae Lee, 2014), enhance their cognitive development through the learning cycle (Karplus, 1977) and transfer student's attitudes from learner to a peer-educator.

To support teachers with effective lesson plans and curriculum development demands in their traditional one-way superficial learning, they may need an interactive design and development strategy. One of the educational design strategies for helping educators to find adequate methods to meet society needs and to provide concepts while fostering sustainable development is the learning cycle. The learning cycle is the process whereby knowledge is created through the transformation of experience (Kolb, 1984). Students need to relate new ideas to their experience and place new ideas into a framework for understanding (Bransford, Brown, and Cocking 2001). Also students need to a unique instructional design technology (IDT) that facilitates learning and improve performance by creating, using and managing appropriate instructional and non-instructional interventions (Definition Terminology Committee of the Association for Educational Communications and Technology, 2007). Thus, the learning cycle is a critical learning process in improving learning environment with better retention of concepts, improved reasoning ability, and superior processing skills in developing local education than would be the case with traditional instructional approaches (e.g., see Karplus and Their, 1967; Abraham and Renner, 1986; Beeth and Hewson, 1999;).

Our aim is to design the appropriate educational design research is threefold; a) to enhance student's conceptual skills, b) to improve learning and knowledge retention through peer-educator approach for sustainable development, and c) to support inexperienced teachers with effective learning guide to develop both interventions in practice and reusable knowledge. In order to achieve that, we implemented multiple

cycles of design, form, inform , and reform (FIR). The FIR learning cycle model was supported by both quantitative and qualitative experimental studies-enhanced peer educator approach based on the new 6E learning concepts. In order for teachers and students to effectively engage teaching and learning approaches that would develop a sustainable learning environment, they may need significant changes in the learning environment that provides by exposing effectively training and adopting ICT tools. This means that students need to participate in a variety of active roles in an integrated learning process in the way to develop their self-regulation skills with the support of teachers' facilitation. Many elementary teachers in Japan face difficulty in providing integrated activities in their classes. Teachers' busy curriculum-based teaching and lack of some teaching skills made them always in need for the effective method to involve their students in a meaningful learning environment. Also in Egypt, there is increasingly gap between education activity in the urbanized and rural community. There are not many researches on getting benefit of integrating digital tools in school curriculum and educational activity for sustainable development. Thus, providing a learning cycle instructional model to experiment student in creating DVD materials would enhance their learning approach and conceptual skills. In order to engage students in longitudinal learning environment, the self-regulation activity implemented in our model focused on forming the self-engagement, informing self-achievement and reforming the dissemination of students' information to the community.

1.1 Definitions of Important Terms

Critical thinking- the process of purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation and inference.

Critical thinking skills - combination of skills including induction, credibility, observation, deduction, and assumption identification. Cornell Critical Thinking Test, Level X, will be used to measure these skills.

Educational for sustainable development - Education for Sustainable Development means including key sustainable development issues into teaching and learning. It also requires participatory teaching and learning methods that motivate and empower learners to change their behavior and take action for sustainable development.

Instructional design research - Instructional Design is the practice of arranging media (communication technology) and content to help learners and teachers transfer knowledge most effectively.

Learning cycle - is a model of instruction based on scientific inquiry. This model encourages students to develop their own understanding of a scientific concept, explore and deepen that understanding, and then apply the concept to new situations.

Self-regulation skill - Active participation in terms of behavior, motivation, and metacognition in one's own learning process

Traditional method – is an instructional method in which students are passively receiving all information from the teacher and the textbook.

1.1 Significance of the Study

UNESCO has identified ten aspects that support quality education related to development of the learner's education. Four of these aspects are: a) acknowledging the learner's and experience, b) making content relevant, c) using many teaching and learning process, and d) enhancing the learning environment (UNESCO, 2005). Pedagogies associated with the education for sustainable development (ESD) stimulate learners to ask questions, analyze, think critically and make decisions. Such pedagogies move from teacher-centered to student-centered lessons and from memorization to participatory learning (UNESCO, 2012). One of the effective participatory learning environments based on educational design is the learning cycle style, in which learner experiences, develops conceptual skills and contributes in a meaningful learning environment. Thus, the adoption of ICT-enhanced learning cycle model in an educational design study is an essential aspect not only to provide educational solution in ESD, but also to reduce the gap between the urbanized and rural students' educational resources.

The aim of the learning cycle model in this study is not only to enhance participatory learning and develop conceptual skills, but also to transform learner's academic attitudes from learner to peer-educator. Within this frame, the learner will be able to develop self-efficacy, self-regulation and be an active user of the ICT tools in ESD. To achieve that, the study provided the chance to grow students as active learners and to enhance their skills and capacity to learn and contribute.

The proposed FIR/6E learning model provided the opportunity to both teachers and students to engage in a real-life study and a longitudinal learning environment. Within the process, the FIR/6E model provided ongoing feedback to teachers and students that can help guide the

learning process, enhance academic achievement, develop acquisition of leadership skills, and promote individual learner/social's contribution in ESD. Also providing a variety of techniques such as qualitative, quantitative assessments, formal and informal evaluations, teachers helped students employ and develop different learning processes.

In ESD literature, there is a need to add new learning models that aim to:

- provide practical solutions to the limitation of local education
- enhance student's conceptual skills
- improve learning and knowledge retention through peer-educator approach for sustainable development, and
- to support inexperienced teachers with effective learning guide and instructional technology material.

CHAPTER 2

REVIEW OF RELATED LITERATURE

2. Executive summary

2.1 Introduction

The instructional technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning (Steels & Richey, 1994). In the last decades, many researches proved the impact of the Instructional Systems Development (ISD) and the applicability of models in enhancing learning environments (Paquette, 2001; Angleli and Valanides, 2005; Berikan et al., 2015). To align with these findings, it is essential to implement an instructional learning guideline and training for teachers and students based on an interactive instructional model in a meaningful learning environment. This model may support novice designers in having practical experience education and other sustainable development.

Based on the above issues for the development of instructional system in education, four research topics are delineated and discussed in this literature review. The four major topics are;

1. Technology-enhanced learning environment.
2. Instructional design development linked to learning styles.
3. Instructional design enhanced learning skills.
4. From design research to large-scale approach.

2.2 Overview of the literature review

In the first topic, common technology-enhanced learning environment and educational design are reviewed. The educational design research is briefly discussed in section 2.3. The

characteristics of the educational design research are very important to educational development activities; thus section 2.3.2 briefly discusses the seven characteristic of educational design. The impact of educational design research in developing activities is presented in section 2.3.3, and section 2.3.4 discusses how educational design enhances real-life situation in a meaningful environment.

In the second topic, section 2.4.1 discusses how learning styles play an essential role in implementing educational design. The importance of the instructional design heuristics are briefly elaborated based on the Delphi technique in the section 2.4.2.

In the third topic, section 2.5.1 discusses the impact of the educational design in developing self-regulation learning skills, and in section 2.5.2, the learning cycle instructional model as an instructional design development is briefly introduced. In section 2.5.3, the limitations and ineffective of other educational designs are briefly elaborated. Finally, a longitudinal learning environment was briefly highlighted and how to get benefit of the educational design in education for sustainable development. This large-scale approach is discussed in section 2.6.1.

The limitation of this literature review are discussed in section 2.5.

2.3 Technology-enhanced learning environment

In the realm of the definition and application of technology-based learning environment (TBLE), Technology-based learning and instructional systems through which students acquire skills or knowledge, usually with the help of teachers or facilitators, learning support tools, and technological resources (Steven, 2008). According to the international board of standards for training, performance, and instruction (ibstpi) assumptions, the instructional design is an effective tool that aimed at the transfer of training and improved individual and organizational performance indicators (Richey et al., 2001). Wang & Hannafin (2005) focused their principles on the application of design-based research to TBLE in order to improve educational design and implementation based on collaboration among researchers and practitioners in real-world setting.

2.3.1 Educational design research

Educational design research (EDR) as inquiry-based learning to TBLE often provides empirical insights and theoretical advancements to support scientific problem solving processes. Over the last 30 years, researchers lunched the educational design research as a specific genre of scientific inquiry (Brown, 1992 & Collins, 1992). In her article in the *Journal of the Learning Science*, Brown discussed how to integrate the educational innovations into real world classroom in a design experiment. While Collins argued that the education should be viewed as a design science in real classrooms. By the turn of the millennium, the research on educational design has increased including; developing conceptualization (Ven den Akker et al., 2006) developing methodology (Kelly, Lesh, & Baek, 2008), and conducting design studies in across

educational fields (McKenney & Reeves, 2012). The need for research is critical aspect to the models and processes implemented by designers and developers (Richey and Klein, 2014). Thus, The EDR as a type of inquiry to the technology field would be an empirical practice in a meaningful learning environment, in which educators develop the creation of new knowledge, the validation of implemented processes and develop both interventions in practice and reusable knowledge in a sustainable learning environment.

In the last decade, more researchers investigated the impact of the EDR on making a contribution to the educational practice (Reinking & Bradley, 2005; Wang & Hannafin, 2005; Mackenney & Reeves, 2012; Bannan-Ritland & Baek, 2008; Lina & Eylon, 2006; Thomas et al., 2009; Klopfer & Squire, 2008; Oh, 2011). This contribution demonstrated through two motives; the first motive focuses on what society needs while the second has more to do with finding adequate methods to meet those needs (Susan & Thomas, 2014). In order to achieve both motives, the implementation of an effective instructional design is needed to develop both interventions in practice and reusable knowledge.

2.3.2 Characteristics of the educational design research

The effectiveness of the EDR to enhance productive teaching and learning environments are based on its seven characteristics; pragmatic, grounded, interventionist, iterative, collaborative, adaptive and theory-oriented. According to Susan & Thomas these characteristics can be identified as followings;

- EDR is pragmatic because it generates usable knowledge and solutions to problems in

practice,

- EDR is grounded because it uses empirical findings to guide work,
- EDR is interventionist because it undertaken to make change in the educational context,
- EDR is iterative because it evolves through multiple cycles of design,
- EDR is collaborative because it requires the expertise of multidisciplinary partnership,
- EDR is adaptive because it requires emerging insights, and
- EDR is theory-oriented because it is undertaken to contribute to a boarder scientific understanding.

Steven (2008) provided another rationale that is the instructional design could become more productive by linking its efforts to other educational development activities. Therefore, conducting an instructional design in education for sustainable development would provide sustainable solutions in developing the local education.

2.3.3 Educational design research linked to development activities

Based on this rationale of linking EDR to other educational development activities, the contribution of the integrative learning ADDIE design (Bannan-Ritland 2003), the learning cycle 5E design (Bybee, et, al., 2006), and other educational design (Ejerbo et al., 2008; Reeves, 2006; Gravemeijer & Cobb, 2006; MacKenney & Reeves, 2012) effectively took place in developing the dual outputs of knowledge and intervention. The table 1 highlights the different phases for conducting educational design researches.

Table 1. Integrative design models

Design	**ADDIE Model (Steven, 2000)**	**5E Model (Bybee, 2006)**	**Mckenney & Reeves Model (2012)**
Phases	• Analysis • Design • Development • Implementation • Evaluation	• Engagement • Exploration • Explanation • Elaboration • Evaluation	• Analysis/Exploration • Design/Construction • Evaluation/Reflection
Objectives	Dynamic, flexible model for developing effective and efficient instruction	Learning cycle model for developing conceptual learning environment	Generic model for maturing intervention and theoretical understanding

Practical outputs in the educational design research are conducted to create educational interventions that address practical problems. These outcomes are illustrated through the findings from a needs and problem statements in the field of educational communications and technology. In exploring variations in design outcomes, Nieveen et al., (2006) highlighted the difference between two theoretical studies in solving education problems; validation studies and development studies. Table 2 illustrates the differences and the practical contribution of both theoretical studies.

Table 2. Design models and practical contribution

Research studies	Validation Studies	Development Studies
Stages	• Environment preparation: elaborating a design based on an interpretative framework • Classroom experiment: testing and improving local instructional theory • Retrospective analysis: studying data of the interpretative framework	• Preliminary research: developing a conceptual framework • Prototyping stage: setting out guideline through formative evaluation and cycle of design • Summative evaluation: explores Scaling and effectiveness • Systematic reflection: Support retrospective analysis
Practical contribution	Development and implementation of specific learning trajectories	Implementation in several contexts

2.3.4 Educational design-enhanced a meaningful environment

Due to the scope of both validation and development outcomes, a significant body of research has called attention to the need of enhancing students' meaningful and active environment through integrative instructional models into learning. These integrative models can transform learning environments to address higher order of thinking skills and teach advanced concepts

(Christensen, 2002; Guzman & Nussbaum, 2009), and develop self-regulation skills (Zimmerman, 2000; Järvelä, Järvnoja and Veermans, 2007; Pintrich, 2000; Dignath et al., 2008) in a longitudinal learning environment.

Within this setting the way in which students engage in learning activities and how to integrate instructional model in enhancing learning and skills are being challenged. In the term of learning activities, teachers strive to provide a meaningful learning which focus on developing students' critical thinking and self-regulation skills. Another critical issue is how to design an effective learning model using integrated technology to assist teacher's lesson plan and authentic materials. To support teachers with effective lesson plans and curriculum development demands in their traditional one-way superficial learning, they may need to a suitable instructional model. The learning cycle has been embraced in science teacher education as a suitable instructional model (Rubba, 1992) consistent with the goals of the *National Science Education Standards* (*NSES*) (National Research Council, 1996).

2.4 Instructional design development linked learning styles

Learning style preferences play an essential role in the instructional design development. Incorporating cognitive ability and learning styles in technology-enhanced educational design supports learners and makes learning easier for them (Sabine & Kinshuk, 2008).

Several different researches investigated on the learner's characteristics such as different cognitive ability (Arroyo et al. 2006; Woolf, 2006; May & Massa, 2003), learning style (Kolb,

1984; Briggs-Myers, 1962; Lin and Kinshuk, 2005), prior knowledge (Shute et al., 2005; Shih et al., 2006; Lee and Nelson, 2005) and motivation (Hede, 2002; Astleitner & Wiesner, 2004). Cognitive abilities and learning styles play an important role in education; for example, cognitive overload may hinder the process of learning and yield to poor performance (Sabine & Kinshuk, 2008). Thus, the instructional design should be suitable for the learner's ability and avoid the cognitive overload.

2.4.1 Educational design in different learning styles

Adaptive learning technologies in educational design provides an environment that intelligently adjusts to a learner's needs by presenting suitable information, instructional materials, and feedback based on learner's individual characteristics and situation (Sabine & Kinshuk, 2014). Sabine & Kinshuk classified the concepts of adaptive learning technology into four types: learning styles, cognitive abilities, affective states and the current learning context/situation. Table 3 indicates the models and approaches.

Table3. Models and approaches

Concepts	**Learning styles**	**Cognitive abilities**	**Affective states**	**Learning context**
Types	Felder-Silverman Learning style (Felder & Silverman, 1988)	Cognitive Trait Model (GTM) (Kinshuk & Lin, 2004)	Khan et al. (2010)	Hwang et al. (2008)

Application	Four dimensions: • Active/reflection • Sensing/intuitive • Visual/verbal • Sequential/global	Four abilities: • Working memory capacity • Inductive reasoning ability • Processing speed • Associated learning ability	Four elements: • Confidence • Effort • Independence • Confusion	Five situations: • Personal context • Environmental context • Feedback • Personal data • Environmental data

Table 4 introduces some of the most common classifications of learning styles and dimensions in the filed of adaptive technologies in educational systems including the Felder-Silverman learning style model (Felder & Silverman, 1988) and Myers-Briggs Type Indicator (Briggs-Myers,1962).

Table 4. Learning styles in educational systems

Learning styles in educational systems		
	Dimensions / Elements	**Functions**
Felder-Silverman Learning style	*Four dimensions:* • Active / reflection	• Active learners learn best by working actively with the

(Felder & Silverman, 1988)	• Sensing / intuitive • Visual / verbal • Sequential / global	learning materials. • Relate the learned materials to the real world. • Learners interact best when they work on visual materials. • Sequential learners learn in small leaps with a well-structured path through the course, while global learners learn in large leaps with independent work through the course.
Myers-Briggs Type Indicator (MBTI) ***(Briggs-Myers, 1962)***	*Four dimensions:* • Extroversion / introversion • Sensing / intuitive	• Extrovert attitude is to focus on the learners' surroundings. Introvert attitude is to focus on learners own thoughts and ideas. • Sensing learners prefer to

		receive data from their five senses. Intuitive learners prefer to receive data from the unconscious.
	• Thinking / feeling	• Thinking dimension is based on the logical connections. Feeling is based on more evaluation.
	• Judging / perceiving	• Judging learners prefer step-by-step structure. Perceiving learners prefer more flexible structure.

2.4.2 Instructional design heuristics / Delphi technique

Through the use of the instructional design competencies in the literature, researchers have been trying to understand how experienced instructional designers apply their knowledge in problem-solving process (York & Ertmer, 2011; Eseryel 2006). Instructional designers adopt their models to specific situation by using heuristics based on the Delphi technique (York & Ertmer, 2011). According to Dudezak (1995), heuristics are general guidelines that experienced designers apply when making decisions during ill-structured problem solving. In their study, York & Ertmer (2011) reported the instructional design heuristics competencies as outlined by

the International Board of Standards for Training, Performances, and Instruction (IBSTPI 2000). Table 5 shows the 23 IBSTPI instructional design competencies classified in four categories; professional foundation, planning and analysis, design and development, and implementation and management with essential and advanced purposes. The Essential purpose is for all instructional designers while the advanced is for experienced instructional designers.

Table 5. IBSTPI Instructional design competencies

IBSTPI Instructional Design Competencies
Professional Foundations
1. Communicate effectively in visual, oral and written form. (Essential)
2. Apply current research and theory to the practice of instructional design. (Advanced)
3. Update and improve one's knowledge, skills and attitudes pertaining to instructional design and related fields. (Essential)
4. Apply fundamental research skills to instructional design projects. (Advanced)
5. Identify and resolve ethical and legal implications of design in the work place. (Advanced)
Planning and Analysis
6. Conduct a needs assessment. (Essential)
7. Design a curriculum or program. (Essential)
8. Select and use a variety of techniques for determining instructional content. (Essential)
9. Identify and describe target population characteristics. (Essential)
10. Analyze the characteristics of the environment. (Essential)
11. Analyze the characteristics of existing and emerging technologies and their use in an

instructional environment. (Essential)

12. Reflect upon the elements of a situation before finalizing design solutions and strategies. (Essential)

Design and Development

13. Select, modify, or create a design and development model appropriate for a given project. (Advanced)

14. Select and use a variety of techniques to define and sequence the instructional content and strategies. (Essential)

15. Select or modify existing instructional materials. (Essential)

16. Develop instructional materials. (Essential)

17. Design instruction that reflects an understanding of the diversity of learners and groups of learners. (Essential)

18. Evaluate and assess instruction and its impact. (Essential)

Implementation and Management

19. Plan and manage instructional design projects. (Advanced)

20. Promote collaboration, partnerships and relationships among the participants in a design project. (Advanced)

21. Apply business skills to managing instructional design. (Advanced)

22. Design instructional management systems. (Advanced)

23. Provide for the effective implementation of instructional products and programs. (Essential)

The results of York & Ertmer (2011) provided insights into the specific heuristics experienced designers perceive as being effective during the instructional design process. Thus, designers should know what design is and why it is important and how effective it is in order to face any problem-solving situation. The IBSTPI four categories are elaborated in;

1. In professional foundation competency, the designer knows how to communicate with all learners involved in the lifecycle of the project (McDonald, 2008).
2. In planning and analysis competency, the heuristic supports the findings of Rowland and DiVasto (2001) who stated that analysis is one of the " big ideas" that designers use when engaging in design process (cited in York & Ertmer, 2011, p 853).
3. In design and development competency, active learning can be promoted through different methods (Mayer, 2003).
4. In implementation and management competency, the instructional design is the team process (Lui et al. 2002 " cited in York & Ertmer, 2011, p 854").

2.5 Educational design linked learning skills

Within this setting the way in which students engage in learning activities and how to integrate instructional model in enhancing learning and skills are being challenged. In the term of learning activities, teachers strive to provide a meaningful learning which focus on developing students' critical thinking and self-regulation skills. Many researchers found that

self-regulation has positive effect on elementary school students' learning outcomes (Dignath et al., 2008) and motivation (Cleary & Zimmerman, 2004; Pintrich & Schunk, 2002). Recently, the research in self-regulation has increased to integrate an appropriate learning model into lesson plans and curriculum development demands including students' motivation (Weimer, 2002) and developing their meaningful learning environment (Project Kaleidoscope, 2006).

2.5.1 Educational design linked to self-regulation skill

Another critical issue is how to design an effective learning model using integrated technology to assist teacher's lesson plan and authentic materials. Thus, self-regulated instructional model would have an impact on both teachers' teaching and students' active learning environment. In which students would assume responsibility for both identifying and monitoring individual learning goals, select means to support their learning (Michael et al., 2014), enhance their cognitive development through the learning cycle (Karplus, 1977) and transfer student's attitudes from learner to peer-educator.

To support teachers with effective lesson plans and curriculum development demands in their traditional one-way superficial learning (Bransford et al., 2000), they

may need an interactive learning cycle instructional system to enhance student's critical thinking, self-regulation skills (Zimmerman, 2000) and improve learning and knowledge retention for sustainable development. However, in order for teachers and students to integrate teaching and learning approaches that would develop a sustainable learning environment, they may need significant changes in the learning environment by exposing an effective instructional system. This means that students need to participate in a variety of active roles in an integrated learning process in the way to develop their self-regulation skill with the support of teachers' facilitation. Many elementary teachers in Japan face difficulty in providing integrated activities in their classes. Teachers' busy curriculum-based teaching and lack of some teaching skills made them always in need for the effective method to enhance their teaching environment. Thus, providing a learning cycle activity to experiment student in creating DVD materials would enhance their learning approach. In order to engage students in longitudinal learning environment, the self-regulation activity implemented in our model focused on forming the self-engagement, informing self-achievement and reforming the dissemination of students' information to the community.

2.5.2 Learning cycle approach

The learning cycle is the process whereby knowledge is created through the transformation of experience (Kolb, 1984). Students need to relate new ideas to their experience and place new ideas into a framework for understanding

(Bransford, Brown, and Cocking 2001). Thus, the learning cycle is a critical learning process in improving students' self-regulation approach with better retention of concepts, improved reasoning ability, and superior processing skills in developing local education than would be the case with traditional instructional approaches (e.g., see Karplus and Their, 1967; Abraham and Renner, 1986; Beeth and Hewson, 1999).

Many versions of the learning cycle introduced in scientific studies with concepts ranging in number from three (Karplus and Their, 1967) to five (Bybee, 1997) to seven (Eisenkraft, 2003). The common 5E model introduces unique instructional elements of understanding and actively building new knowledge from prior knowledge. It incorporates the three core learning cycle phases, explore, introduce and apply or extend while adding two conceptual changes, engage and evaluate. The 5E model mainly focuses on developing student's formulation of a better understanding of scientific and technology knowledge within peers and their environment. Some researches found that students taught via a learning cycle scored higher on a test than students taught with traditional style (Gerber, Cavallo & Marek, 2001). Figure 1 shows the 5E model and its conceptual elements relationship.

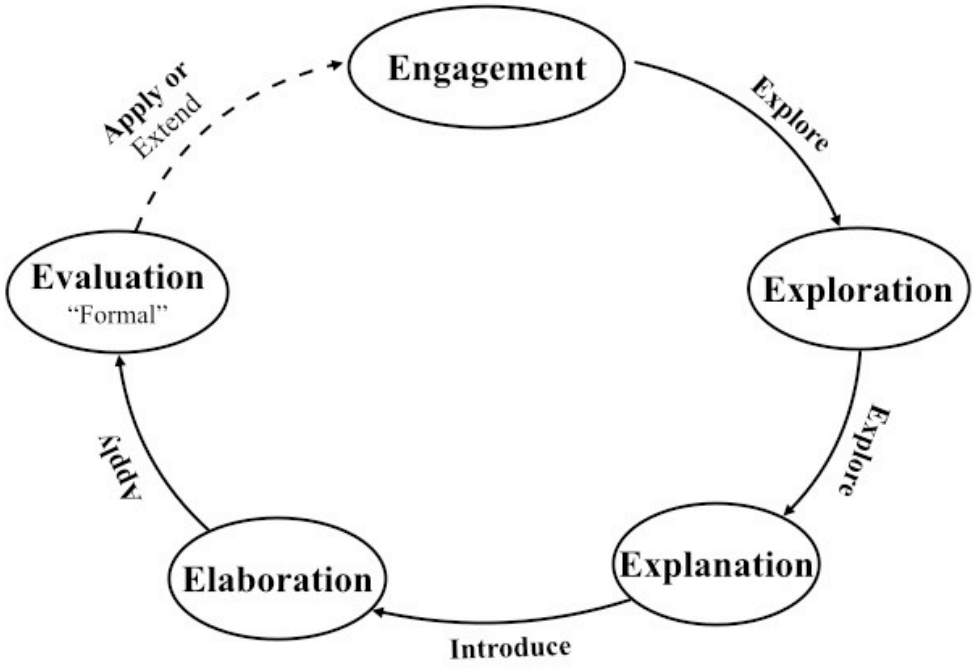


Figure 1. The 5E Conceptual Elements

The 5E introduces the formal evaluation as the main reflection on students overall achievement. However, the 5E model is based on formal evaluation and reflection, which implemented at the end of the whole process. This may affect on students' motivation. Therefor, involving students in sustainable multiple experiences with formal and informal evaluation assessments may improve students' long-term self-achievement and attitudes. In order to develop long-term outcome of student's self-regulation and motivation skills teachers need to engage their students in social tasks and teach students how to use them productively (Joyce and Weil, 1996) in a longitudinal learning environment.

2.6 From design research to large-scale approach

Using instructional models in developing education is an essential process to enhance large-scale approaches. The validation of these models, external and internal, is an empirical process that demonstrates the effectiveness of a models use in a real-world setting (Richey, 2005). Thus, the research and development are integrated to create educational interventions that address practical problems (Mckenney & Reeves, 2014). The research and development of guideline or design frameworks in the field of education for sustainable development are needed. Educational design, as a social actor, plays role in raising social awareness (Hamdani, 2012). Therefore, students can bring social changes for their societies if they receive appropriate training and education (Laessoe, 2010).

2.6.1 Learning cycle model for sustainable development

Dealing with social problems needs knowledge, ability to think critically and skills to act (Roy al et., 2012). The United Nations Educational, Science and Cultural Organization (UNESCO) investigated the major problems in developing societies; 1) the lack number of teachers and qualification, and 2) the lack of appropriate sustainable instructional tool, which focus on competencies of integrating educational technology into teaching (DSED 2005-2014). The learning cycle system as a technology-enhanced society would hopefully provide a learning guideline for a sustainable environment. Also integrating the learning cycle system in a collaborative learning real-world situation is considered as another hope for developing teachers and students meaningful learning environment. In his study, Zanaty

(2009) proved that collaborative learning study based on multimedia-enhanced social, cultural and academic attitudes improved both teachers and students interaction.

2.6.2 The proposed FIR/6E learning cycle in education for sustainable development

> The proposed learning cycle phases of Form, Inform and Reform (FIR) is designed to promote the 6E conceptual elements; experiment, explore, explicate, elaborate, evaluate and extend. The FIR-6E instructional model assigned to provide the opportunity to maintain three learning aspects; a) forming the self-experiment and self-reflection, b) informing self-achievement in longitudinal learning environment and c) reforming the dissemination of students' information to the community in sustainable local and international environments. These learning aspects illustrate the learning guidelines in education for sustainable development.

Cognitive scientists insist that students need to relate new ideas to their experience and place new ideas into a framework for understanding (Bransford, Brown and Cocking, 2001). Also in order to contribute these ideas in a meaningful and sustainable learning environment, the authors introduce the FIR phases and its 6E conceptual elements in where students can develop their self-regulation skills as peer-educators. The FIR phases were designed to increase students' productivity in education for sustainable development. This means that students are to participate in a variety of active roles in an integrated learning process in the way to develop their self-regulation skill in creating digital learning materials with the support of teachers' facilitation. Thus, the FIR phases are supported by qualitative and quantitative assessments of self-achievement informal evaluation right after each phase in order to maintain the validity and reliability of the methodology. The expected impacts of the instructional

design of our research study would; a) provide self-regulated students an opportunity to organize their set goals in order to achieve more appropriate outcomes goals, b) provide students an opportunity to develop self-observation, self-experimentation in a longitudinal learning environment, c) provide an opportunity for the dissemination of students' information to the community. Figure 2 shows the FIR phases and its 6E conceptual elements relationship.

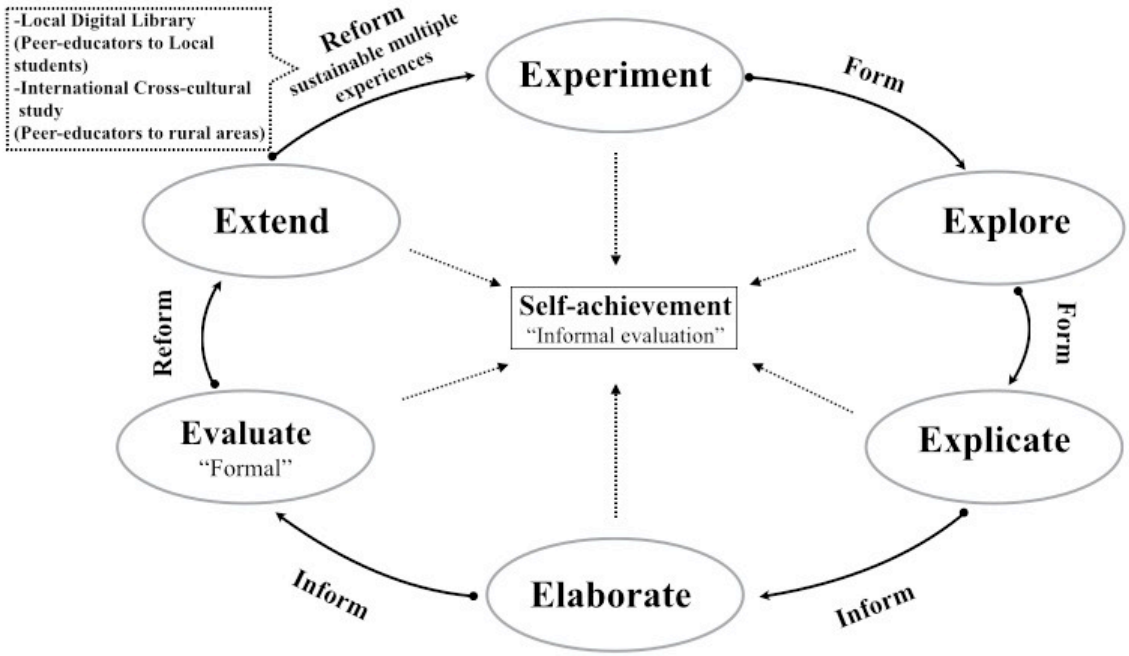


Figure 2. The FIR-6E Conceptual Elements For Sustainable Development

The above system illustrates the relationships and prescribed actions between conceptual elements. The FIR-6E system provided both descriptive and prescriptive processes. As a descriptive process, the system shows relationships and illustrates what happens within interactive environment in a variety of roles and responsibilities. As a prescriptive process, the system shows a variety of procedures; assign methods and a guide of self-regulated activity through self-achievement assessments.

The overall idea of the above literature review is that the development of learning approaches and conceptual skills, self-regulation and critical thinking, are a crucial and vital topic in education for sustainable development. Designing instructional learning activities to promote student's conceptual skills is not a new approach in education literature. However, none of the studies in the reviewed literature directly investigated the effect of integrating a sustainable learning cycle model-enhanced peer-educator approach on the improvement of learners in local communities. Therefore, in this study, the effect of the sustainable FIR-6E model on the improvement of both teachers and students' meaningful learning environment is investigated.

CHAPTER 3

RESEARCH PROBLEMS

This chapter presents the main problem and the sub-problem of the current study.

3.1 The problem statements

The problem statements of this study is twofold:

1. What is the effect of the sustainable FIR-6E Learning Cycle Model on the improvement of the peer-educator approach of education for sustainable development?
2. What is the effect of the sustainable FIR-6E Learning Cycle Model on the improvement of teachers and students' conceptual skills and contribution?

3.2 Sub-Problems

1. Is there a significant difference between the effect of the sustainable FIR-6E Learning Cycle Model and that of traditional method on the improvement of teachers and students' conceptual skills and contribution?

2. Is there a significant difference between the effect of the sustainable FIR-6E Learning Cycle Model and that of traditional method on the student's variation in learning behavior?

CHAPTER 4

4. METHODOLOGY

4.1 Guidelines

In this section we attempt to provide guidance to novice designers and teachers who are looking for interactive learning system. The method is based on Collins et al., (2004)'s guidelines for carrying out design research. Table 6 shows the guidelines and its rationales.

Table 6. Design research guidelines

Guidelines	Rationales
Implementing a design	To evaluate; how the design fit the problem-solving, and how well it implemented.
Modifying a design	To improve; the way the design operates, and the transitions between phases.
Multiple ways of analysis	To maintain; the interaction between teacher and student, student to student, student to group and how well the resources integrated into the activities
Measuring dependent variables	To measure; how sustainable the design is and how to effectively implement both qualitative and quantitative evaluations.
Measuring independent variables	To measure; how to use the design in different settings, how effectively the design fit the

	types of learners, how teachers can get benefits of adjusting the setting to their own situations.
Reporting on design research	To document; the inputs, outputs and outcomes of each phases and reflection in order to extend the activities in large-scale approaches.

4.2 The outcome of FIR/6E in education for sustainable development

4.2.1 Form phase: *Learning & Training*

The form phase illustrates two learning approaches, which are input and output, as well as two learning concepts, experiment and exploration in an attempt to learn and train students on how to access self-regulated learning materials. Tomlinson (2010) emphasized the effective input in learning environment. He stated that in order to acquire the ability to use the language effectively the learners need a lot of experience of the language being used in a variety of different ways for a variety of purposes. They need to be able to understand enough of this input to gain positive access to it and it needs to be meaningful to them. With this in mind, this phase introduces a variety of different learning ways, which allow students the opportunity to

turn their one-way learning style to a more active-learning approach through the necessary resources. If we have necessary resources (web, digital tools, content expertise), then we can design and deliver an instructional model appropriate for our educators (Taylor and Henert, 2008).

Consistent with the intent of form phase, our initial activity is intended to elicit elementary students' prior knowledge about the learning environment. The activity designed in; form groups, roles, solve problems, design a group task scenario, and apply what they learnt to develop their skills. The process is supported with assessment of student attitudes and performance sheets. At the end of each period of the process, students are asked to record their achievements through informal evaluation sheet and process guide sheet. The process guide sheet was designed to record student's self-regulation progress that will enable them to maintain their motivation and their life-long learning attitude (Boekaerts and Corno, 2005).

In addition, the form phase developed two concepts of instruction: (1) *Experiment*, which provides students with the opportunity in experimenting in self-regulated pedagogies, connecting their past and present learning experiences, and opportunities to learn independently and from one another and, (2) *Explore*, which provides students with opportunity to investigate

and develop their contexts through integrated digital learning tools including PC, digital cameras, tablets and editing applications. By exposing these concepts, students will be able to engage in an effortful and mindful experience with a variety of active roles such as; innovators, self-developers, problem-solvers, co-thinkers, challengers, and meaning-makers that led them to contribute in an on-going learning environment.

4.2.2 Inform phase: Intervention & *Active learning environment*

The in-form phase is critical for maintaining an active learning environment following the initial activities of this study. The activities in this phase focuses on developing two learning approaches: outputs and short-term outcomes, and two learning concepts: explanation and elaboration, in an attempt to maintain an active and a meaningful learning process. In order to achieve that, we incorporate the self-regulated learning with productive learning in a group work. The activity intends to shift student attitudes from that of being a passive learner to peer-educators.

The task including; deliver and access each group's digital content, designs group scenario and creates an illustrated guide according to each student's responsibility. The teacher's role is to facilitate and observe the gradual achievement. Consistent with the

intent of the inform phase of the FIR-6E instructional model, the activity intends to elicit students' prior experiences and skills, demonstrates students current understanding and selects the appropriate form to be used in sustainable development experience. Taylor and Hernet also stated that if we design and deliver this instructional module, then our educators would access it and learn about and develop skills in logical models. At the end of each period of this phase, the students are asked to record their task achievement through student evaluation sheet and process guide sheet. The next stage will elaborate how the assigned interactive activities will assist in developing meaningful outcomes in a longitudinal learning environment. The interactive activities focused on the collective and shared activity of group members in a real-world situation that maintained motivation. According to Jackson, Mckenzie and Hobfoll (2000) motivation is created and maintained through the collective, interactive and even shared activity of group members. Kolb in his 1984 paper titled Experiential Learning: *Experience as the Source of Learning and Development*, referred to an old aphorism accredited to confucius around 450 B.C.: "Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand." Cited in Handbook of Research On Educational Communications and Technology, 3rd additions, (2008).

In addition, the Inform phase develops two concepts of instruction: (1) *Explicate*, which allows students to compare methods and achievement of

other group in an interactive learning environment, and to be able to present their method in easy features in the last phase case study. Here the role of the homeroom teacher is to facilitate the process and group presentations. (2) *Elaborate*, which provides students with the opportunity to develop their skills in logic models and implement their experience in a sustainable learning experience. By exposing these concepts, students will be able to expand their learning approach and their ability of English communication and cross-cultural awareness.

*4.2.3 Reform Phase***;** *Longitudinal learning cycle*

To apply what students have learnt, the reform phase is planned to reflect on a new sustainable learning experience as peer-educators. It also provides a summative assessment for teachers and students to evaluate their interaction. The activities in this phase focus on the longitudinal learning cycle and the reflections on the impacts of the FIR-6E instructional model on students' attitudes. The reform phase illustrates two learning approaches, which are outcome and impact, as well as two learning concepts, evaluation and evolution in an attempt to reflect and create a new learning situation effectively. In this phase, we incorporate the productive learning with the learning cycle process in a group work learning style. This phase allows students to reflect their applied skills and integrates these skills

into real-world activities (Merrill's, 2002).

In addition, the reform phase developed two concepts of instruction: (1) *Evaluate*, which allows students to exchange feedback with an international partner, learns new methods, and improves conceptual pedagogy and, (2) *Extend*, which provides students with the opportunity to reengage in a new sustainable learning cycle. Gradually, students' motivation will increase by implementing a new experimental process. At the end of this phase students will be able to conduct four effective experiential learning elements: (1) concrete experience, (2) observation and reflection, (3) formation of abstract concepts, and

(4) testing in new situations (Kolb 1984). By exposing these concepts, students will able to reflect, challenge themselves in a new learning situation at their own pace and disseminate their information to the community in a new sustainable learning development.

4.3 6E conceptual elements

The meaningful environment orientation effectuated a shift from materials to be presented in an instructional system to students' goal-oriented and self-regulated process with the instructional design system (Cooper, 1993). At present, there is an emerging focus on using K-12 students in studies using digital learning equipment. The present researches show higher level

of students' motivation by the self-regulated elements of digital learning environments (Foster, 2008). As such, we need to implement an effective instructional learning system to be use in education for sustainable development at local schools. Therefore, we designed the FIR-6E model as a sustainable learning instructional system for fifth elementary students in Japan to enhance a meaningful learning approach. The FIR-6E conceptual elements include;

4.2.1 Experiment / Form phase

During this element process, students experiment a variety of digital equipment and editing softs. Students are to develop their basic skills to integrate digital equipment in a self-regulated process and understand how to create a cross-cultural DVD/digital contents. Teachers provide training and facilitate the progression of all tasks. Teachers create a folder for storing and evaluating the target cross-cultural DVD/digital contents. Tasks are designed in small group work. For informal evaluation, the process is arranged through the group problem solving action process, see Appendix B & C, and evaluated by self-achievement card, see Appendix A.

4.2.2 Explore / Form phase

This element is connected to the initial element process through the group

tasks. Students work in groups and develop their digital contents. Students create their action and timeline plan. Students create illustrated scenario with individual role. Students make predictions, develop hypotheses, collect data and draw conclusion through the self-created scenario. Teachers facilitate process observe interaction and scaffolding. For informal evaluation, the process is evaluated by self-achievement card, and conducted through step-by-step action plan activities, see Appendix D.

4.2.3 Explicate / Inform phase

This element is connected to the explore process through providing the opportunity to students explicates their methods, finding, discoveries. Students have opportunity to explicate how they implemented their digital equipment in detail to other groups. Students select one digital equipment and editing soft to develop a cross-cultural DVD. Teachers allow opportunities to develop ideas and concepts. Also teachers' role is to follow groups' action plan and self-achievement evaluation process. For informal evaluation, the process is evaluated by self-achievement card and step-by-step action card.

4.2.4 Elaborate / Inform phase

Based on the self-created action plan and illustrated scenario in the previous process,

groups marge methods and digital equipment in creating the DVD contents. Students use past and present experience in new interactive learning experience. Exchange DVD with international partners. The target DVD contents are to teach some sort of the Japanese traditional games, language and sports. Teachers facilitate process and observe students' interaction. For informal evaluation, the process is evaluated by self-achievement card and step-by-step action card.

4.2.5 Evaluate / Reform phase

Students work on experiment reflection. Students receive intrinsic feedback from local learners or international partners. Understand the impact on their work. Students develop more critical thinking and self-regulation skills through a new learning cycle process to be introduced to local learners or in sustainable experience. The role of students' transforms from active learners to peer-educators. Teachers provide feedback and assist in new learning cycle process. For informal evaluation, the process is evaluated by self-achievement card, step-by-step action card and teacher's observation.

4.2.6 Extend / Reform phase

In order to transform the peer-educators' new learning interest into a longitudinal learning environment, students develop new learning cycle process with more self-efficacy and self-regulated skills. Students contribute their past and present experiences in a sustainable learning case study. Teachers facilitate process and

observe students' motivation and interaction. For informal evaluation, the process is evaluated by self-achievement card, step-by-step action card and overall interviews.

CHAPTER 5

5.The FIR/6E case study

5.1 Method of research

The purpose of this study was to investigate the effect of the integration of creating DVD into learning cycle pedagogy for local education development, and at the same time ensure that the students' self-regulation and critical thinking were not jeopardized by the implementation of the FIR/6E learning cycle model. It was also necessary to investigate whether digital equipment could assist students in an active learning environment and could expand their motivation in a longitudinal academic achievement by determining the effectiveness of the proposed FIR/6E learning cycle model as an alternative to the traditional style. The FIR/6E model was implemented in this study to transfer students' outcome from learners to active peer-educators. To achieve that, students had the opportunity to experiment how to access digital equipment in order to work on their pace, explore and create effective learning DVD materials for local education and cross-cultural sustainable development. The FIR/6E was supported with self-achievement and self-created action plan as self-management process that enhanced students' self-regulation and critical thinking skills. Figure 3 shows the FIR/6E instructional model and both local and international case studies architecture.

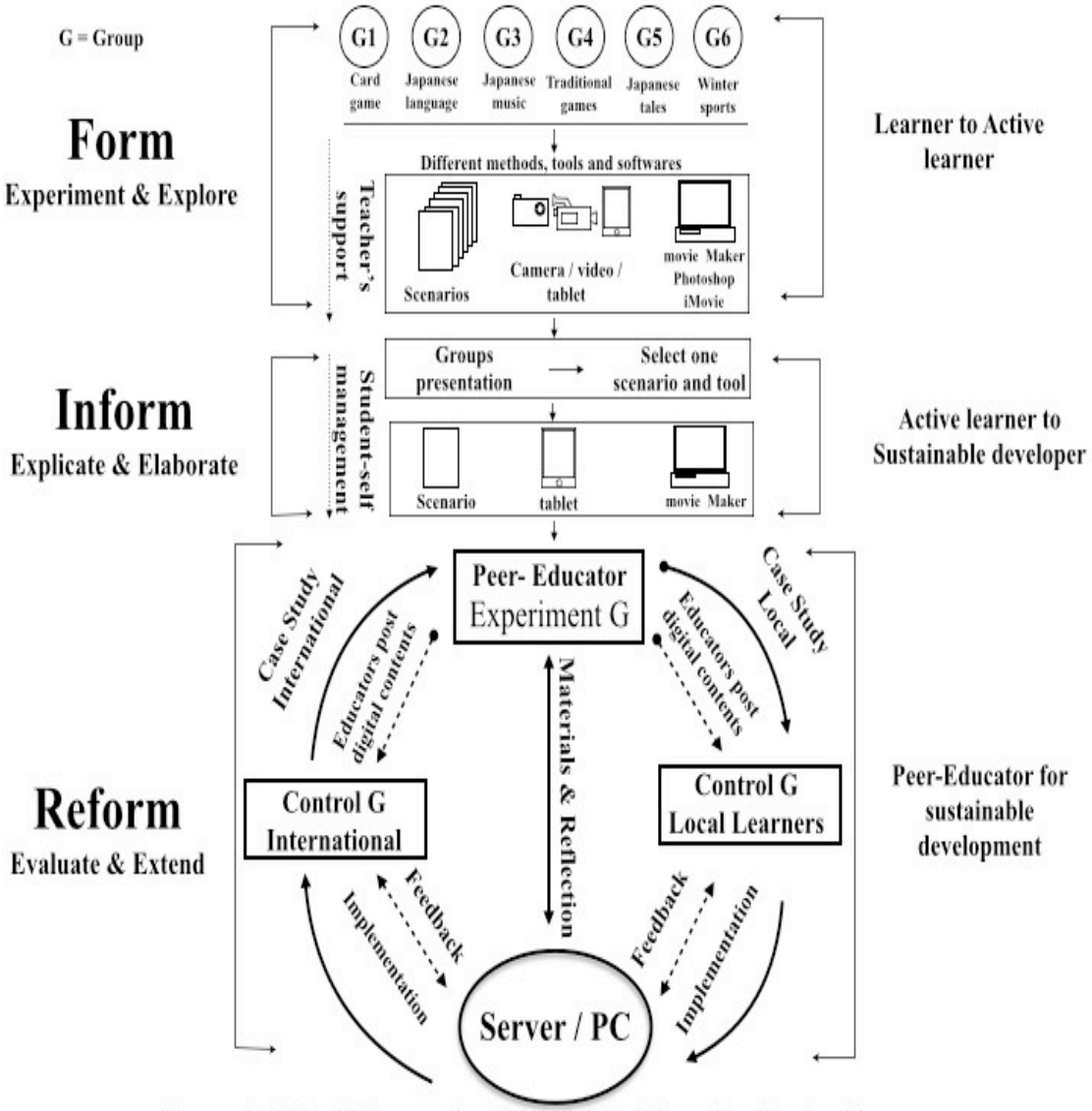


Figure 3. FIR-6E Instructional Model and Case Studies Architecture

5.2 Design

Within the FIR/6E model, an action research was implemented, and both qualitative and quantitative data were collected. The quantitative components in this study were integrating technology tools in teaching and learning, creating a self-created action plan and creating an illustrated scenario. These components, as a part of a developmental

research method, were used to develop students' engagement in authentic tasks (Schank and McPherson, 1999). According to Babette and Tim (2011), technology can equip students to independently organize their learning process. So, instead of being passive recipients of information, students using technology become active users. The self-created action plan and illustrated scenario were used to develop the proposed FIR/6E method for the integration of creating DVD materials in learning cycle. According to Schank and McPherson, the goal-based scenario is a learning by-doing simulation in which students pursue a goal by practicing target skills and using relevant content knowledge to help them achieve their goal. Thus, the scenario in this study had a critical part of developing the whole process of this study and keep students in a longitudinal motivation. See figure 4.

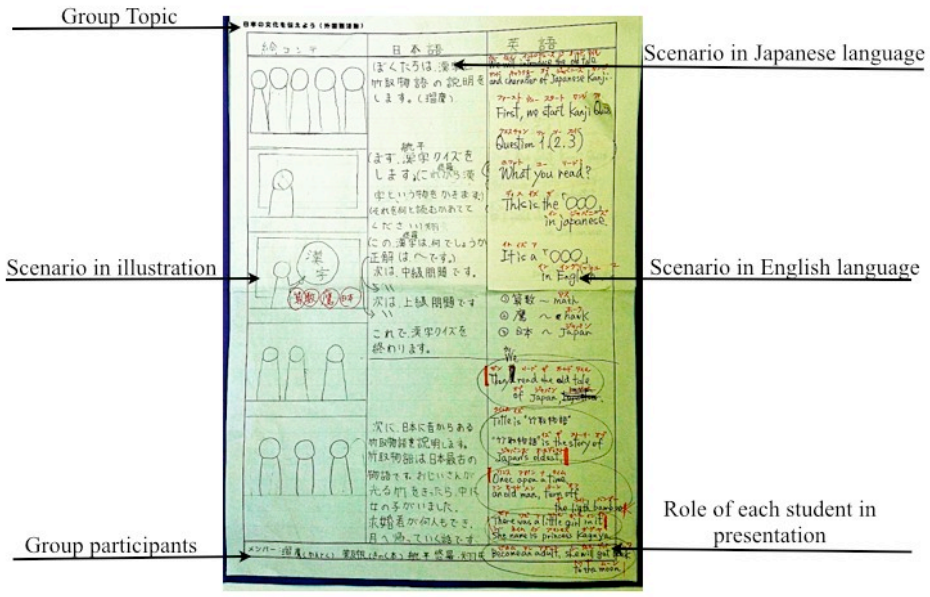


Figure 4. Form Stage / Students' Self-created Scenario Strategy

5.3 Tools

The digital tools assisted students in developing their conceptual experiences and allowed them to design appropriate digital content. Components included tablets, one for each group, PC editing applications such as flash and moviemaker and internet resources.

5.4 Participants

The quantitative components assisted to develop learning and skills of local children based on a sustainable learning cycle instructional approach in creating DVD using digital equipment. We applied the FIR-6E instructional model at Higashi Ainonai elementary school in Japan. Three case studies were designed to monitor the gradual progress in transferring students' outcomes from learner to peer-educator. This paper introduces two case studies, in which we have already carried out. The third case study will be implemented during the next process as the extension of this research. In case study one, 30 students in experimental group were exposed to the common 5E model while 30 students of control group were exposed to a traditional learning style. In case study two, the same experimental group were exposed to the proposed FIR-6E instructional model as peer-educators in education for sustainable local development role while the same control group were engaged as local learners in this experiment. The experimental group ranged from 10 to 11 years of age, 20(67%) males and 10 (33%) females. Groups and topics are described in table 7. None of participants

had any previous formal experience in the FIR-6E instructional model study before taking part in this project. The control group was exposed to regular twelve class based on teacher-centered learning style. The same students, as experimental group, were exposed to the 6E model in semester two in another twelve integrated periods of study, twice a month according to the school curriculum. The implementation of the study was designed in 45 minutes each for each period. Control group was taught cross-cultural classes on Egypt based on teacher's materials. As for experimental group, students were experienced in training and creating digital materials on their culture and school life based on the FIR-6E instructional model. Students produced cross-cultural digital learning materials to be delivered to Egyptian students in which they applied their formed experiences in a new sustainable learning development case study.

Students randomly selected three main roles as following;

a) a writer was chosen to take notes on their group's scenario and strategies based on all members' contributions,

b) an editor was chosen by in peers to develop their group's digital content,

c) a photographer was chosen to document all activities by tablet and digital camera. Figure 5,6 and 7 show the implementation of digital tools and roles in the FIR-6E instructional model phases.

Table 7. Experimental group (N=30)

Groups	Theme	Numbers	Boys	Girls
Group 1	Japanese traditional wood games	5	3	2
Group 2	Japanese card games	5	4	1
Group 3	Sports / skating	5	4	1
Group 4	Language / tales	5	3	2
Group 5	Eating manners	5	3	2
Group 6	Japanese instruments	5	2	3

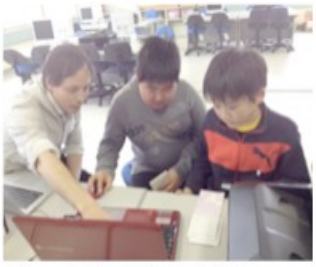


Figure 5. Form Stage. PC Literacy

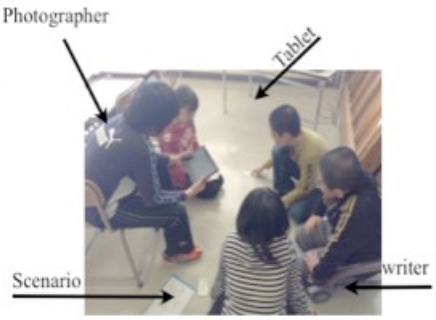


Figure 6. Inform Stage. Implementation

Figure 7. Reform Stage. Longitudinal learning cycle

For the qualitative component of the study, various data-collection methods were used. We assessed performance, motivation and attitudes towards the FIR-6E model in all integrated periods of both case studies by descriptive statistics and multiple data sources. Assessments were used to explore students' transfer of learning (Bohler, 2011), and to verify the implementation of FIR phases as a case of 6E. The use of multiple methods, or methodological triangulation (Ashatu 2009), helped to increase credibility of the FIR-6E instructional process. The main instruments include the following:

5.5 Assessments

5.5.1 The student's learning performance and self-achievement cards

With the collaboration of teachers and the author, the student's learning performance and

self-achievement cards were designed. The purpose of student's learning performance card was to visualize group behavior and performance in terms of central tendency and dispersion (Brown, 2006). The purpose of student's self-achievement card was to help students manage and evaluate their task-centered, activation, demonstration, application, and integration (Merrill, 2000) through all integrated periods of both semesters. Each student was required to fill in the card manually after each period. The expected time for completing each card was 10 minutes. The cards consisted of four parts; part one and two were focused on students' self-evaluation rated on a five-point Likert-style (1. 2. 3. 4. 5.) scale. The Score 1 indicating favorable response toward the level of engagement and a score of 5 indicating an unfavorable response as following; SA =Strongly Agree, A = Agree", DNA = Do Not Agree, SDNA = Strongly Do Not Agree, and IDK = I don't Know. Part three was an open-ended question about overall activity in each period, and part four was about the students' next challenge. At the end of all integrated periods of this study, students in each group were required to hand in the card to the facilitator in the group. All cards were collected by the teacher and analyzed with the author to measure students' self-engagement and motivation.

5.5.2 Teacher's questionnaire

A questionnaire consisted of two parts were adapted from Hammer (2013) SCALE (Students-Centered Arts-Learning Environment project) with some changes added by the authors, see Appendix E. The first part of the questionnaire was about the teacher's background. There were 8 questions with four choice statements in the second part. For the questions, teachers selected one answer out of four statements on the effectiveness

of the project. All questions investigated the effectiveness of the implementation of the FIR-6E instructional model process on students' attitudes, motivation and the usefulness of the applied method.

The collected data from interviews and questionnaires were analyzed in different ways. Interviews were analyzed based on students' answers on the effectiveness of the FIR-6E instructional experiment. The questionnaires were analyzed by calculating percentages of frequency, and 4 open-ended questions were analyzed by evaluating the teacher's explanations. The findings from the semi-structured questionnaire were analyzed and arranged in the FIR-6E instructional process development pyramid.

5.7 Assumptions and Limitations

5.7.1 Assumptions

1. Students were active in all experiment process
2. Process was carried out based on students interactive roles and teachers positive support
3. Guidelines were organized under systematic design model and conceptual elements
4. The model aimed at the transfer of training and improving teachers and students

5.7.2 Limitations

1. The subjects of this study were limited to 30th fifth grader student in Japan and a similar number from Egypt. Their learning styles may be different from other students.
2. This study was limited in certain periods of study at the Japanese school.
3. Students may need more time for mastering technology tools application.

CHAPTER 6

6. Findings and discussions

To evaluate the use of the FIR-6E instructional model process materials for this experiment, students explored to two learning styles of teacher-centered learning, in semester one, and the FIR-6E style, in semester two in twelve integrated periods of study. Respondents who participated in this evaluation were aged in 10 to 11 years old. Participants were 20(67%) males and 10 (33%) females for total 30 students set involved.

6.1 Student's learning performance / period by period card

The descriptive statistics were interpreted to visualize group behavior and performance in terms of central tendency and dispersion (Brown, 2006). Table 8 indicates a significant difference between the experimental and control group through the all three indicators of the central tendency in case study two. Clearly, the experimental group is higher on all three indicators and, therefore, performed better with the implementation of FIR-6E instructional model. Also the variation in learning behavior was clearly presented at the range and the standard deviation. The experimental group

Table 8. Differences in indicators of the central tendency

	Central Tendency			**Dispersion**			
Group	Mean	Mode	Median	Low	High	Range	SD
Experimental	17	19	17	15	19	5	36
Control	7	9	7.5	6	9	4	16

6.2 Students' self-achievement card findings

The students' self-achievement evaluation card played a critical role in illustrating the

impact of the FIR-6E instructional model compared to the common 5E model. The results of case one and case two were analyzed base on the academic achievement in self-regulated approaches including task-centered, activation, demonstration, application and integration. Figure 8 shows the slight learning gain that the experimental group who engaged in the FIR-6E instructional model process than when they were exposed to the common 5E model. As an example, the task-centered was evaluated in two statements, *I engaged in all periods* and *I participated in creating learning materials.* The first statement of *I engaged in all periods* showed slight difference of students' curiosity in involving themselves in the FIR/6E instructional model with rate 94% while with 5E model, rate indicated 93% while the experimental group, rate indicated 94% engagement. The control group had less interaction with the 5Es process and this emotion had gradually changed to a higher academic approach. In the second statement of *Creating materials for local development approach increased my interest in process* showed the significant impact of students' self-created materials in involving themselves in the FIR-6E instructional model environment. With 5E students had less interaction and this emotion had gradually changed to a higher academic approach with the FIR-6E instructional model.

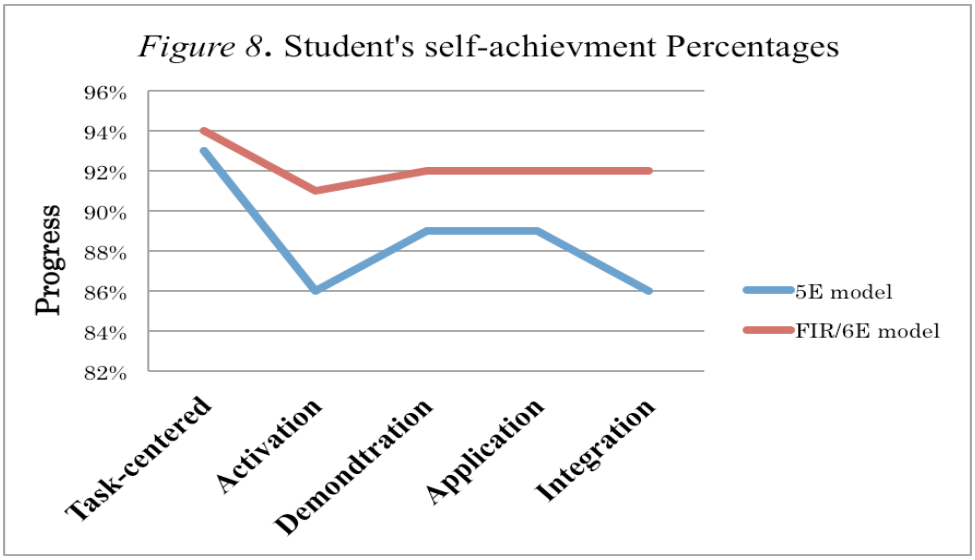


Figure 8. Student's self-achievment Percentages

6.3 Student questionnaire findings

The research questions investigated that training on the FIR-6E instructional model

learning leads to an improvement of self-regulated learning variables. The overall findings of two studies showed significant differences between the experimental group and control group in enhancing students' self-regulation and motivation. The student questionnaire showed that, 66% of respondents believed the FIR-6E instructional model to be effective. See figure 10. In terms of motivation, 53% of respondents agreed that the FIR-6E instructional model motivated them to achieve their goals. See figure 11. 70% of respondents agreed that they could work of their own pace with the FIR-6E instructional model more so than traditional methods. In terms of multimedia tools, 53.4% agreed that the FIR-6E instructional model provided a variety of learning tools in order to develop their own content. In terms of engagement, 66.8% respondents agreed that they engaged full time in the process. Also 66.7% respondents agreed that they enjoyed the FIR-6E instructional model learning class. In order to confirm the results, 73.4% of respondents disagree with the statement "*I did not enjoy the* FIR-*6E learning class*". Another two statements were investigated on which style the students do admire. The first statement of "*I like traditional class better that the FIR-6E model learning* " 30% of respondents agreed, 43% disagreed and 26.7% respondents said "*I don know*". The second statement of " I *prefer the 6E style more than traditional class*" 36.8% agreed, 30% disagreed and 33.4% said "*I don know*". See figure 12.

Figure 9. FIR/6E model/ Effectiveness Percentages

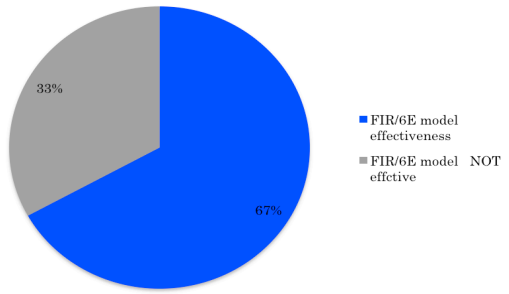


Figure 10. FIR/6E model/Motivation Percentages

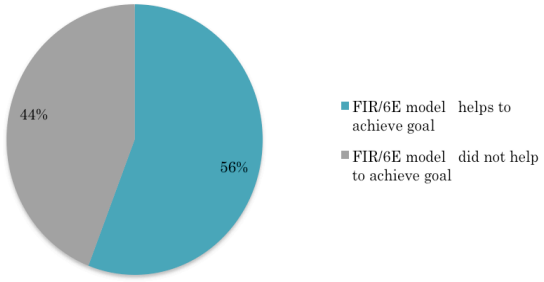
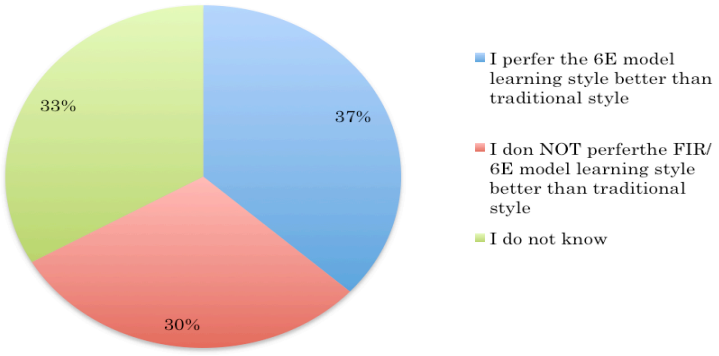


Figure 11. FIR/6E model & Traditional style Evaluation



6.4 Teacher questionnaire findings

In the teacher questionnaires findings, the multiple data sources showed positive remarks on the effectiveness of the FIR-6E instructional model. The questionnaire was to measure six major aspects including; self-regulation skills, student's engagement, student's conceptual improvement, student's motivation, student's cultural awareness and psychological learning development. Teachers selected one statement out of four that indicate how far the FIR-6E instructional model was useful learning guide for students to extend their learning approach from active learner to more meaningful learning environment. Sample findings of Q13 are displayed in eight sections of four multiple-choice statements. The selected statements are displayed in the learning pyramid based on the psychological learning developing factors; cognitive and metacognitive are represented in sections 1 & 2, motivational and effectiveness are represented in sections 3 & 4, social is represented in sections 5 & 6 and individual differences are represented in sections 7 & 8. The eight findings are arranged from the bottom to the top of the pyramid based on the three stages of the 6E instructional process Form, Inform and Reform. See figure 12.

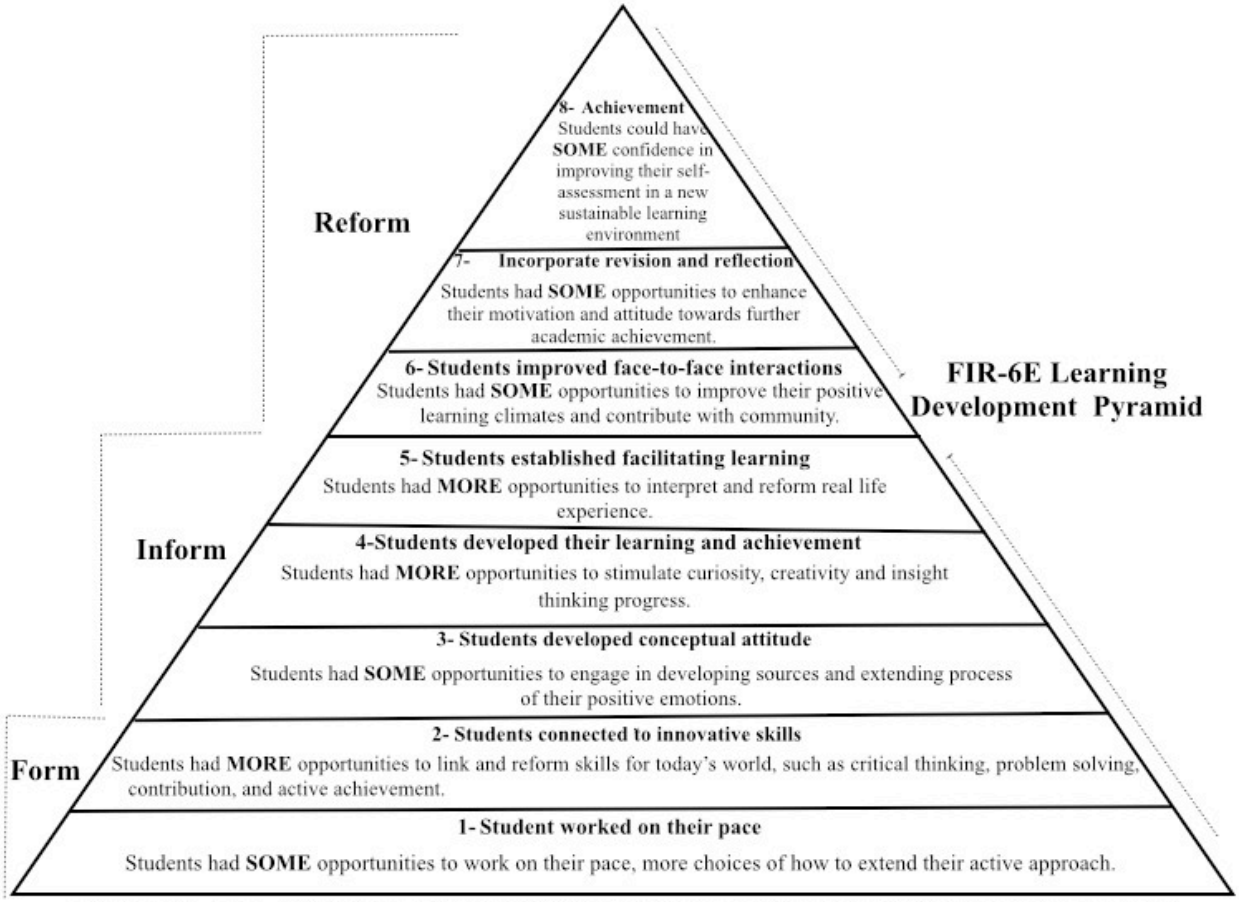


Figure 12. FIR-6E teacher's questionnaire findings/Q13/Students' Psychological Outcomes

CHAPTER 7

7. **Conclusions and recommendations**

7.1 Conclusions

In conclusion, this study indicates that the majority of students were positive regarding the integration of digital equipment and self-created DVD in the learning cycle study for the local education development. It also shows how to integrate an effective FIR/6E instructional model effectively in teaching and learning. The results also showed the FIR-6E instructional model three characteristics; a) whole meaningful tasks are seen as the driving force for learning, b) developing the learner-centered in the way to act as co-responsible for a process of competence development, and c) It provided a renewed interest in learning approach through the benefit of integrating technology in education for sustainable development. The experimental group in both two case studies could develop self-regulated skills such as problem-solving, goal-based scenario, higher critical thinking and active peer-educator approach through the dissemination of their information to the community.

The proposed FIR-6E instructional model does not aim to promote the technology equipment but how to integrate the digital equipment to promote learning in sustainable development in local area. The FIR-6E instructional model is not to belittle the impact of the common 5E model but to promote a longitudinal learning

model to enhance local learners society.

Finally, the FIR-6E instructional model was well liked by the teachers and students in the current two case studies. The FIR-6E model provided opportunity to learners to act as peer-educators, gain confidence about creating a change in their learning environment and experiment critical role contributing education for sustainable development.

Students who have participated actively in this experiment have received a useful learning guide in order to form a strategy, inform their knowledge and perform their creativity in a meaningful experience. Among the advantages that the student gained;

- Gradual progress in the learning approaches and the significant transformation from knowledge-receiver to educator.
- Gradual progress in learning skills such as strategy-maker and community developer.
- Gradual progress in the interactive learning style through communicative, self-engagement and innovative activities.
- Gradual progress in conceptual and cognitive learning outcomes through positive learning environment and developing learning concepts for sustainable learning development.
- *Overall principles promotion the FIR-6E*

The promotion of the FIR-6E principles is based on Merrill (2000). The implementation of the FIR-6E model promoted some approaches for facilitating

effective, efficient, and engaging instruction. Table 9 Shows the instruction principles, promotion and its rationales.

Table 9. Instruction principles, promotion and its rationales

Principles	Promotion	Rationale
Task-centered	Learners undertake a progression of all tasks	To develop students self-engagement
Activation	Learners implemented self-regulation skill	To develop conceptual understanding and increase motivation in learning
Demonstration	Learners used a variety of methods	To develop self-efficacy such as reducing anxiety
Application	Learners shared an active learning environment	To develop pairs and group learning
Integration	Learners integrate their new learning	To develop meaningful learning environment

7.2 For future implementation:

1. To implement the extensional case study three in education for sustainable development.
2. To extend the use of the FIR-6E into academic institutions.
3. To promote the FIR-6E instructional model to agencies like UNESCO and should be used more widely to promote important issues in the field of education.

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