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Message from the editor-in-chief

Malaysian Online Journal of Educational Technology (MOJET) highlights the current issues in educational technology. MOJET is an international, professional referred journal in the interdisciplinary fields sponsored by Faculty of Education, University of Malaya. This journal serves as a platform for presenting and discussing the emerging issues on educational technology for readers who share common interests in understanding the developments of the integration of technology in education. The journal is committed to providing access to quality researches ranging from original research, theoretical articles and concept papers in educational technology.

In order to produce high quality journal, extensive effort has been put in selecting valuable researches that contribute to the journal. I would like to take this opportunity to express my appreciation to editorial board, reviewers and researchers for their valuable contributions to make this journal a reality.

Professor Dr. Saedah Siraj
October 2016
Editor in chief

Message from the editor

The Malaysian Online Journal of Educational Technology (MOJET) is aimed at using technology in online teaching and learning through diffusing information from a community of researchers and scholars. The journal is published electronically four times a year.

The journal welcomes the original and qualified researches on all aspects of educational technology. Topics may include, but not limited to: use of multimedia to improve online learning; collaborative learning in online learning environment, innovative online teaching and learning; instructional design theory and application; use of technology in instruction; instructional design theory, evaluation of instructional design, and future development of instructional technology.

As editor of the journal, it is a great pleasure to see the success of this journal publication. On behalf of the editorial team of The Malaysian Online Journal of Educational Technology (MOJET), we would like to thank to all the authors and editors for their contribution to the development of the journal.

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October 2016
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A Model Of Critical Peer Feedback To Facilitate Business English Writing Using Qzone Weblogs Among Chinese Undergraduates

Gao Xianwei [1], Moses Samuel [2], Adelina Asmawi [3]

ABSTRACT

The purpose of this study was to explore critical thinking skills in peer feedback for Business English writing in order to facilitate the quality of peer feedback and quality of Business English writing. "Critical peer feedback" was conceptualized with the integration of “critical thinking” and “peer feedback” in order to improve the quality of peer feedback. This study explored the process, content and factors of critical peer feedback through Qzone weblogs, and summarized the model of critical peer feedback. A qualitative case study was conducted with a group of six junior students majoring in Business English for one semester in a Chinese university. Three models of critical thinking including Revised Bloom’s Taxonomy, Paul-Elder Model and Reichenbach’s Six Steps Model, were transferred to the participants in the workshops. Three kinds of data including semi-structured interview transcripts, six writing assignments and artifacts of critical peer feedback, were analyzed by QSR NVivo 8. The findings revealed that the Revised Bloom’s Taxonomy is more acceptable for the beginners of critical peer feedback which provides a six-step model of critical thinking. The process of critical peer feedback in online context was summarized as four steps- “intake”, “critical thinking”, “output”, and “post-output”. Each of the four steps had several mental processes in critical peer feedback. This study may be significant for the knowledge of higher-order peer feedback to facilitate the quality of higher-level writing.

Keywords: Critical peer feedback; critical thinking; Business English writing; online feedback; Qzone weblog

INTRODUCTION

Peer feedback is referred under different names such as peer response, peer review, peer editing, and peer evaluation (Bijami, 2013). It emphasizes the activity of peer involvement in learning. Peer feedback in EFL writing has been regarded as time-consuming, and inefficient (Song, 2010; Zhang, 1995). Peer feedback needs to be specific, appropriate, high-quality, timely, accurate, constructive, outcome-focused, encouraging, positive, understandable and focused on what is done correctly and what needs to improve (Gielen & De Waver, 2015; Konold & Miller, 2005). Peer interaction is cardinal to improving students’ learning, because it allows students to construct knowledge through social sharing and interaction (Lin, Liu, & Yusanet, 2001).

There are arguments on the positive and negative effects of peer feedback. Mory (2003) summarized four perspectives on how feedback supports learning: 1) an incentive for increasing response rate and/or accuracy; 2) a reinforcer that automatically connects responses to prior stimuli (focused on correct responses); 3) Feedback can be considered as information that learners can use to validate or change a previous response; 4) Feedback can be regarded as scaffolding to help students construct internal schemata and analyze their learning processes. Peer feedback can generate more comments on the content,
organization, and vocabulary (Paulus, 1999). Yang, Badger, and Yu (2006) articulated that peer feedback can develop critical thinking, enhance learner autonomy and social interaction among students. Peer feedback allows students to receive more individual comments as well as giving peers opportunities to practice and develop different language skills (Lundstrom & Baker, 2009). Lange (2011) believed that students should be allowed to give feedback without constraints, and explore their ideas without fear of criticism from the teacher. In addition, Nicol and Macfarlane-Dick (2006) articulated that peer feedback enhances the students’ sense of self-control over their learning.

The major criticism of peer feedback is that although students express positive attitudes toward using peer feedback, they tend to significantly favor feedback by teachers (Yang et al., 2006; Zhang, 1995). Saito and Fujita (2004) found that a number of studies indicated that a number of biases were associated with peer feedback including friendship, reference, purpose (development or grading), feedback (effects of negative feedback on future performance), and collusive (lack of differentiation) bias. Another issue is that most peer feedback focus on products rather than the process of writing, and many students in L2 contexts focus on sentence-level errors rather than the content and ideas (Storch, 2005).

Peer feedback is mainly aimed at improving writing with high quality feedback. A basic research question is how to produce high quality peer feedback in writing and what is the strategy to produce higher-order peer feedback. There are few studies on how to improve the quality of peer feedback and improve the ability of writing. In this study, critical thinking skills will be conducted in peer feedback to produce higher-quality peer feedback.

**Process, Content and Factors of Peer Feedback**

Peer feedback holds the four theoretical frameworks including social constructivism, sociocultural theory, Vygotsky’s Zone of Proximal Development, and interaction in second language acquisition (Hyland & Hyland, 2006; Lai, 2016). These theories emphasize the role of “peer” in different perspectives. For the perception of peer feedback, peer feedback is identified as a valuable approach in higher education (Lai, 2016). Some researchers believed that peer feedback can promote in-depth learning, the development of professional practice and self-praise skills (Hyland & Hyland, 2006; Lai, 2016; Morris, 2001). However, some pointed out the drawbacks such as the high cost of organizing and supervising the peer feedback process, students’ lack of trust in peer feedback, low efficiency and time-consuming (Hovardas et al., 2014; Llado et al., 2014; McGarr & Clifford, 2013). Recent studies indicated that peer feedback can be associated with a larger degree of student autonomy (Yang et al., 2006). The self-efficacy of students and knowledge foundation is the basis of peer feedback.

Although the broad studies of effectiveness of peer feedback are conducted in different settings and participants on the content, forms and error analysis of peer feedback, the positive and high-qualified performance (or result) of peer feedback cannot be generated automatically. The generation of positive results and high-qualified performance of peer feedback, like teachers and experts, depends on the peers’ psychometrical and cognitive process of thinking. The systematic, logical and comprehensive critical thinking process is a crucial strategy to improve the quality of effective peer feedback; yet very few studies have been done in this area, which is a gap in the literature on peer feedback.

On the study of the peer feedback process, Topping (1998) identified the explaining, simplifying, clarifying, summarizing, reorganizing and cognitive restructuring in the activities of peer feedback. Most researchers studied the activity process of peer feedback such as error correction, first peer feedback, revision, second peer feedback and third peer feedback (Hyland & Hyland, 2006; Liang & Tsai, 2016). However, there was limited study on the mental or psychological process of peer feedback.

Feedback content and feedback form are the main recognized types of feedback. Strijbos, Narciss, and Dunnebier (2010) investigated two types of feedback: simple feedback type providing outcome-related information, and elaborated feedback type providing additional information besides outcome-related information. Simple feedback components are knowledge of performance, knowledge of result, and knowledge of correct response. An elaborated feedback component is dependent on the elaborated information provided, which might address: a) knowledge on task constraints (provides information on task rules, task constraints and task requirements); b) knowledge about concepts (provides information on
conceptual knowledge); c) knowledge about mistakes (provides information on errors or mistakes); d)
knowledge on how to proceed (know how) (provides information on procedural knowledge); and e)
knowledge on meta-cognition. The knowledge of feedback is crucial for the effectiveness of feedback.

The question of which feedback content is most efficient (i.e., which has the most beneficial effects on
performance), has received much attention in prior feedback research. Several authors have emphasized the
“mindful processing” of feedback as a critical factor for feedback efficiency (Narciss, 2008; Poulos & Mahony,
2008). Unfortunately, the results of a large body of feedback researches are mixed. Only some studies
support the common sense assumption that elaborated and specific feedback affects performance more
positively than concise general feedback (Mory, 2003; Narciss, 2008; Shute, 2008). Ilgen, Fisher, and Taylor
(1979) considered expertise as one of the most important factors for feedback acceptance. Expertise of
feedback source is expected to depend on factors such as training, experience, competence level, and
familiarity with the task domain (Birnbaum & Stegner, 1979).

Ellis (2003) recognized four types of factors for individual differences in learning - ability (intelligence,
working memory, and language aptitude), propensities (learning style, motivation, anxiety, personality, and
willingness to communication), learner cognitions (learner belief) and learner actions (learning strategies).
Allen and Katayama (2016) summarized a range of potential factors which can influence the peer feedback
process: the use of first or second language, language proficiency of peers, gender, the language of the
reviewer, learner’s motives, and shared cultural background.

According to the sociocutural theory, sociocultural factors are crucial in peer feedback. “Collectivism”,
“group harmony”, “face-saving”, and “power distance” were critical cultural factors among Chinese students
(Yu, Lee, & Mak, 2016).

Critical Peer Feedback and Writing

According to the previous literature, Pearlman (2007), based on the critical pedagogy, studied to
transcend peer feedback through critical collaborative assessment, and articulated the importance of the
critical peer collaborative learning process. Li (2007) realized the effects of critical assessment training on
quality of peer feedback and quality of students’ final projects in peer assessment, but “critical assessment”
is not further discussed. Cox et al. (2013) reviewed the “ideal preceptor qualities” in peer assessment, one of
which is to encourage critical thinking and problem solving. Ruggiero (2012) made an empirical study of
critical reading and critical writing, but he does not define what is “critical” in reading and writing. Forster
(2007) studied using critical feedback to improve research writing. However, he does not further even define
“critical feedback” and the mechanism of “critical feedback”. “Critical feedback” is still a vague definition in
his writing. Therefore, there are few researchers definitely defining “critical” and “critical feedback” in
education.

Most of the studies concerning “critical” are based on the individual experiences -- the perspective of
empiricism. Zhao (1996) studied “the effects of anonymity on critical feedback in computer-mediated
collaborative learning” and gave a definition of “critical feedback” based on the foundation of “evolutionary
epistemology”. He defined critical feedback as “an essential mechanism in the process of learning, which
helps the learner to realize the inadequacies of his present knowledge” (Zhao, 1996, p. 13). This is the rarely
definite definition of critical feedback, which emphasizes the mechanism is essential to knowledge growth,
and the existed knowledge needs reconsideration to construct better theories. Zhao (1996) emphasized the
construction process of knowledge growth and individual role in learning, and anonymous assessment to
reduce the influenced factors of peer feedback in a computer-mediated platform.

In this study of conceptual framework, “critical peer feedback” is different from the term “peer
feedback” in “critical”. “Critical” refers to a deep and comprehensive judgment which comes from the
concept of “critical thinking” in psychology. Based on the previous explanation of critical thinking in
education, critical peer feedback is constructed as a constructive learning method, based on the purposes of:
1) emphasize the constructive process of language acquisition; 2) highlight the individual mental and
psychometrical development in higher education; 3) summarize the effectiveness study of peer feedback and
advocate a systematic and comprehensive process of feedback; 4) explore the effective methods to improve
the quality of peer feedback.
RESEARCH QUESTIONS

The four research questions addressed in this study are:

1. What is the process of critical peer feedback to facilitate Business English writing through Qzone weblogs?
2. What is the content of critical peer feedback to facilitate Business English writing through Qzone weblogs?
3. What are the factors affecting critical peer feedback to facilitate Business English writing through Qzone weblogs?
4. What is the model of critical peer feedback to facilitate Business English writing through Qzone weblogs?

METHODOLOGY

Research Design

This study was carried out in two phases. The first phase focused on the two workshops on the introduction of critical peer feedback and Qzone weblog for online peer feedback in Business English writing. Each three-hour workshop was conducted twice. In the two workshops, three kinds of critical thinking model were introduced to the participants including the Paul-Elder Model (2012), Reichenbach’s Six-step Model (Reichenbach, 2001), and the Revised Bloom’s Taxonomy of critical thinking (Forehand, 2005). Qzone weblog was explored to the participants to conduct online feedback and comments. The objectives of the two workshops are to make the participants grasp the knowledge and skills of critical peer feedback on Qzone weblog. The second phase focused on data collection and data analysis. This study was conducted over one semester during the first semester of 2015-2016. Three kinds of data including semi-structured interview transcripts, six writing assignments and artifacts of critical peer feedback, were analyzed by QSR NVivo 8.

Participants

A large class of 42 students was selected for the research population who were divided into 7 groups for online critical peer feedback in their course of Business English Writing in a Chinese university. Business English has been a discipline in this university for 15 years. A group of 6 students were chosen as the case group. The six case participants (CP) were coded as CP1 to CP6 for anonymous online peer feedback. They have no knowledge of critical thinking and critical peer feedback in English learning. They will have the course of Business English Writing based on the syllabus. The lecturer conducted the course and critical peer feedback among groups on Qzone weblog, and the researcher was only the observer.

Data Collection and Data Analysis

Three kinds of data were collected including semi-structured interviews, artifacts of Business English writing, and artifacts of critical peer feedback. During the second phase, the semi-structured interviews were conducted three times among the six case participants, which were based on the interview protocol (see Appendix). Each interview lasted 30 to 45 minutes. The six Business English writing assignments were written by the case participants based on the syllabus and uploaded on their Qzone for critical peer feedback. The three interviews with each case participant were recorded and transcribed. These qualitative data were analyzed by QSR NVivo 8 with free nodes, tree nodes, and models (see Figure 1). By QSR NVivo 8, 116 free nodes, 4 tree nodes and five models are categorized in this study.
FINDINGS

RQ1: Process of Critical Peer Feedback to Facilitate Business English Writing Using Qzone Weblogs

Based on the data analysis by QSR NVivo 8, the case participants indicated that they adopted the Revised Bloom’s Taxonomy for critical peer feedback. The activities of critical peer feedback included three main parts including “analyzing, evaluating and creating”. However, before the critical peer feedback, they used their prior knowledge of Business English writing for “remembering, understanding and applying” their peers’ writing. Then they attempted to offer their critical peer feedback on their peers’ writings on Qzone.

I adopt the six steps of Revised Bloom’s model. As my understanding, critical peer feedback has a step-by-step process. My critical peer feedback is at the low level from “remembering, understanding and applying”. I still cannot reach the higher level of “analyzing, evaluating and creating”. (Cited from Interview Transcript/CP2/23 Oct., 2015)

To be detailed, their mental process of critical peer feedback could be categorized into three steps. The first step is to “intake” the writing according to their actual performance of Business English writing. This actual ability of “intake” is different among the peers. The second step is “critical thinking” in which the peers adopt Revised Bloom’s Taxonomy of “analyzing, evaluating and creating” to assess the writing. The third step is to write their critical peer feedback on the Qzone. However, the third step is the output of critical peer feedback which display the contents of their critical peer feedback. The output of critical peer feedback is the process of assessment and creation which follows the logical process of praising, error correcting, analyzing the Business English writing tasks, evaluating the writing and creating opinions.

After the process of critical peer feedback, case participants discussed the further activities to react to critical peer feedback. Based on the model of post-activities in critical peer feedback (see Figure 2), the post-activities include proofreading, re-editing, self-reflecting, rewriting and re-uploading for further critical peer feedback. The case participants indicated the post-activities are the actual practice of facilitating Business English writing.
After the uploading of the rewriting, there is a new turn of critical peer feedback for the rewriting which may make the rewriting reach a higher level with more critical peer feedback. However, the rewriting and re-uploading depends on the first writing quality and the writer’s option. In conclusion, the process of critical peer feedback can be concluded with the mental process of critical peer feedback and the post-activities of critical peer feedback. The process of critical peer feedback can be illustrated in the following figure (Figure 3).

In Figure 3, the flow chart starts from “intake” to “critical thinking”, and then “CPF output”, which are the indispensable three parts of critical peer feedback. The post-activities of “CPF output” is a supplement of critical peer feedback. In this flow chart, the solid line of each box represents an actual part, which cannot be omitted in the process of critical peer feedback, while the dotted line represents the optional part. The solid
arrow represents the indispensable flow of the process, while the dotted arrow represents the optional flow of the process.

This mental process of critical peer feedback is based on the model of Revised Bloom’s Taxonomy (Bloom et al., 1956), which illustrates the mental process of critical thinking. This mental process of critical peer feedback also demonstrates the statements of “intake”, “reaction”, “input” and “output” in second language acquisition (Pawlak, 2011; Zhang, 2009). This process of critical peer feedback emphasizes the mental and psychological “thinking” activities during feedback, while most previous studies focus on the activities of “doing something” in feedback such as reading, commenting, discussing, and writing, and so forth (Asikainen, 2014; Lai, 2016; Lee, 2015; Pol et al., 2008). Different models of critical thinking could involve conducting different processes of critical peer feedback.

**RQ2: Content of Critical Peer Feedback to Facilitate Business English Writing Using Qzone Weblogs**

Before this study, the case participants insisted their content of peer feedback is error correction. Their only activity in peer feedback is error correction on grammar, spelling and punctuation. Some studies argued that error correction is ineffective, even harmful to students’ fluency and their overall writing quality (Hyland & Hyland, 2006).

“Generally, when I evaluate a writing, the first viewed in my eyes is grammar error, the second is style, and the third is wording, and then rhetoric like parallelism, affective language. The last is special feature which can attract me.” (Cited from Interview Transcript/ CP3/ 09 Oct., 2015)

“At the beginning of this study, I pay much attention to grammar errors, and not check the sentence logic. But now, I prefer to study its sentence logic, cohesion and coherence. Whether or not they are clear, is very important to a writing.” (Cited from Interview Transcript/ CP2/ 23 Oct., 2015)

With the study of critical peer feedback, the participants realized that there are other aspects to be assessed except error correction. Based on the data analysis by QSR NVivo 8, the main content of critical peer feedback in Business English writing contain the following seven parts such as error correction, discourse analysis, pragmatic functions, rhetoric features, affection, style, and syntax (see Table 1).
Table 1: Contents of Critical Peer Feedback for Business English Writing

<table>
<thead>
<tr>
<th>Contents of Critical Peer Feedback in Business English Writing</th>
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<tbody>
<tr>
<td>Error Correction</td>
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<td>Grammar</td>
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<td>Spelling</td>
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<td>Punctuation</td>
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<td>Discourse Analysis</td>
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<td>Coherence</td>
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<td>Logic</td>
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<td>Pragmatic Functions</td>
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<td>Conciseness</td>
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<td>Attractiveness</td>
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<td>Rhetoric Features</td>
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<td>Parallelism</td>
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<td>Affection</td>
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<td>Business Report</td>
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<td>Syntax</td>
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<td>Cohesion</td>
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<td>Coherence</td>
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The seven parts of contents in critical peer feedback were concluded by data of Business English writing artifacts and their critical peer feedback, which are decided by the syllabus of Business English Writing and the writing assignments in the course. In this study, the contents cannot all be concluded in the practice of their critical peer feedback, which are only parts of it. The content of critical peer feedback includes not only error correction of language, but also every aspect of Business English writing, in addition to the consideration of successful business communication. However, it extended their feedback of error correction from language to writing mechanism.

On the content of peer feedback in L2 writing, some studies focus on error correction (Storch, 2005; Nicol & Macfarlane, 2006); some focus on the functions such as clarity, completeness and expressiveness of writing (Caulk, 1994; Konold & Miller, 2005; Nelson & Schunn, 2009); while some focus on the linguistic features (Paulus, 1999; Ferris & Roberts, 2001; Lundstrom & Baker, 2009). There are few studies on the content of peer feedback in Business English writing. This finding implied that concrete contents and points of critical peer feedback in language and writing mechanism are more helpful and specific to the peer’s writing and editing, which point out the places of correcting and editing.

RQ3: Factors Affecting Critical Peer Feedback to Facilitate Business English Writing Using Qzone Weblogs Among Chinese Undergraduates

Many factors affect the effectiveness of peer feedback in second language writing. Ellis (2003) recognized four types of internal factors such as ability, propensities, learner cognitions and learner actions. Bassham (2009) argued the factors of relevant knowledge information, bias, prejudice, peer pressure, perception, and face-saving. Yu, Lee, and Mak (2016) found the “collectivism and group harmony”, “face-saving”, and “power distance” factors among Chinese undergraduates, but they argued that these factors were not effective in small group peer feedback. In this study, the case participants clearly indicated they were influenced by many factors in critical peer feedback.

According to the data analysis by QSR NVivo 8, the finding of factors in critical peer feedback among Chinese undergraduates could be grouped into two categories: internal factors and external factors. The
internal factors, based on Ellis (2003), were further categorized into four aspects including ability, propensity, peer cognition and peer action. The external factors were also categorized into four aspects of factors including pedagogy, culture, LSP register and environment. The detailed internal and external factors are illustrated in the following Table 2.

Table 2: Factors Affecting Critical Peer Feedback for BEW on Qzone

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<th>Factors Affecting Critical Peer Feedback on Qzone in Business English Writing</th>
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Among the findings of internal factors, the abilities include Business English writing ability, critical thinking ability, peer feedback ability and language proficiency. The ability factors are the “remembering” basic in critical thinking, which directly influence the effect of critical peer feedback. However, according to the theory of ZPD, the peers' abilities are different at various “zones”. The higher-ability peers can help the lower-ability peers to develop their ZPD (Vygotsky, 1978). That statement was confirmed by the participants in this study that the higher-ability peers can help the lower-ability peers to develop their writing (Hsia, Huang & Hwang, 2016; Mintzes, Wandersee, & Novak, 2005). The participants insisted that they preferred to read “good” writings and welcome “good” critical peer feedback.

The peer cognition includes the cognition of peer feedback, critical thinking, critical peer feedback, Qzone, and Qzone for critical peer feedback, which influence the cognition of this study and their actual practices of critical peer feedback. Peer action refers to the peer performance in critical peer feedback such as critical peer feedback strategy, self-autonomy and self-reflection on Business English writing and critical peer feedback. The peer action refers to the actual activities during critical peer feedback, which is also the internal factor of critical peer feedback. The propensities refer to the peer’s preferences in critical peer
feedback such as personality, motivation, willingness, anxiety and inter-language in critical peer feedback. The case participants have the personality of modesty, shyness, timidity and politeness. They insisted that online critical peer feedback is more suitable to their personality compared with face-to-face critical peer feedback, which reduces the face-to-face conflict, embarrassment, and nervousness, and keeps each other’s “face”. The five participants all have instrumental motivations, three for examination, two for jobs. They have weak and unsure integrative motivation for cross-cultural communication. This means that they learn Business English writing for examination (60%) and career (40%), but not for communication. However, the research found that integrative motivation is more active and motivated for learning (Gardner, 2010). Under the supervision of lecturer, the case participants insisted that they were willing to participate in this study and improve their ability in Business English writing. They had little anxiety at online critical peer feedback. They were adapted to apply English for online critical peer feedback, but Mandarin Chinese (mother language) for interviews. This strategy of inter-language indicated that they lack confidence in oral English, but not for written English.

Among the findings of the external factors, the pedagogy included the teaching strategy and learning strategy. In this study, the teaching strategy includes teacher-centered teaching, summative assessment and large class teaching. The participants argued that they need more writing practice and time for critical thinking in Business English writing classes. The present teaching strategy negatively affects critical peer feedback in Business English writing. The participants’ learning strategy included reciting, little interaction, low self-autonomy, inefficient peer feedback, no BEW sharing, and surface writing and learning in Business English writing. The present learning strategy also negatively affects critical peer feedback in Business English writing. This implies the urgent transformation of teaching strategy and learning strategy in Business English writing.

Regarding the factor of culture, the participants insisted that they are affected by Confucianism, collectivism and “face-saving” in the Chinese environment. Under Confucianism, the participants argued that they are modest and polite, and unwilling to argue and discuss among peers. This is a negative factor for critical peer feedback in Business English writing. This is consistent with the statement that Asian students are widely regarded as quiet, polite and modest in class as in China, Japan and Korea (Hyland & Hyland, 2006; Yu, Lee & Mak, 2016). This proved the situation why there was little discussion, argument and communication in critical peer feedback among Chinese undergraduates. Collectivism is defined as a “social pattern of closely linked individuals who see themselves as parts of one or more collectives…and emphasize their connectedness to members of these collectives” (Triandis, 1995, p. 2). The participants are collective members who will do their best to complete the tasks of critical peer feedback for the group benefit and glory. This is a positive factor for critical peer feedback in Business English writing among Chinese undergraduates. “Face-saving” in Chinese culture emphasizes “the harmony of individual conduct with views and judgments of the community” (Liu & Hansen, 2001, p. 205) and “maintaining of group harmony and mutual face-saving to maintain a state of cohesion” (Carson & Nelson, 1994, p.23). “Face-saving” negatively affects critical peer feedback in Business English writing, in which the participants focused more on face-saving than the criticism and “critical” peer feedback in the group work.

Business English writing has a clear register in lexicon, style and syntax (Carter & Nunan, 2001). The participants insisted that specific register of Business English Writing positively offers them a concrete target for critical peer feedback. The environment factor includes technique environment, Internet environment, place and time for critical peer feedback. The environment factors take the positive functions on critical peer feedback in the research setting.

RQ4: Model of Critical Peer Feedback to Facilitate Business English writing Through Qzone Weblogs

According to the theoretical framework of SCT and ZPD, this study defined “critical peer feedback” with the concepts of “critical thinking” and “peer feedback”, focused on the “peer” mental activities in Business English writing at online situation, and studied the mechanism of “critical peer feedback” from the perspectives of process, content and factors in Chinese culture. The “Critical Peer Feedback Model” was concluded based on the mechanism of critical peer feedback in this study.
Based on the process of critical peer feedback at Figure 3, the content of critical peer feedback in Table 1, and the factors affecting critical peer feedback in Table 2, “Critical Peer Feedback Model” in this study can be modeled with the combination of the three parts (see Figure 4). Figure 4 illustrates the four steps of mental activities for critical peer feedback, the content of critical peer feedback in Business English writing, and factors in this study.

![Critical Peer Feedback Model for Business English Writing on Qzone Weblog](image)

In this figure of “Critical Peer Feedback Model”, the flow chart starts from “intake” to “critical thinking”, and then “CPF output”, which are the indispensable three parts of critical peer feedback. The post-activities of “CPF output” is a supplement of critical peer feedback. In this figure, the solid line represents actual activities in the process of critical peer feedback, while the dotted line represents the optional ones. The solid arrow represents the indispensable flow of the process, while the dotted arrow represents the optional flow of the process.

This model contains the main four parts of the mechanism of critical peer feedback. It points out the concrete aspects for the practice of critical peer feedback. It provides a recommendable model of higher-order peer feedback for higher-level writing. From this study, it can be concluded that this model is an ideal model for the beginners of critical peer feedback in higher-level writing or vocational writing instruction. It is
Also valuable for the practice in other subjects for critical peer feedback.

CONCLUSION

Critical peer feedback is a higher-order assessment by peer feedback with critical thinking skills of “analyzing”, “evaluating” and “creating”, which is based on lower-order thinking skills of “remembering”, “understanding” and “applying” of the writing. The Revised Bloom’s Taxonomy of critical thinking is accepted as the skill for critical peer feedback. The students believed that their ability of critical peer feedback could be cultivated by teaching and practicing. Critical peer feedback is accepted as an efficient way to improve Business English writing by collaborative learning in this study. Critical peer feedback provides a strategy of higher-order mental activity to assess the higher-level writing.

On the study of the process of critical peer feedback, the case participants experienced a serial mental activity to 1) “intake” the writing by remembering, understanding and applying with lower-order thinking, 2) use “critical thinking” for analyzing, evaluating and creating the writing, 3) and finally to “output” their “content” of critical peer feedback in written form. After the output of critical peer feedback, these were some post-activities in order to improve their writing and also for further critical peer feedback. The post-activities of critical peer feedback have been categorized into five parts including proofreading, re-editing, self-reflecting, rewriting and re-uploading on their Qzone. After re-uploading the rewriting, the next turn of critical peer feedback might be conducted to assess the rewritten writing. Logically, this process can be repeated until the satisfaction of the writing. However, the demonstration of post-activities is dependent on the condition of the writing quality and the writer’s preference.

The content of critical peer feedback has been summarized at Table 1. Based on the data analysis by QSR NVivo 8 in this study, the content of critical peer feedback includes error correction, discourse analysis, pragmatic functions, rhetorical features, affection, style and syntax. During the process of critical peer feedback, the students’ mental activities of critical peer feedback were affected by many internal and external factors. These factors have been explored in this study (see Table 2). The internal factors are: ability, peer cognition, peer action, and propensities. The external factors are categorized into pedagogy, culture, LSP register, and environment factors.

Many studies on peer feedback model in EFL writing. Nelson and Schunn (2009) discussed the five feedback features in a proposed model of peer feedback. The five features are divided into two parts: 1) cognitive feature including summarization, specificity, explanation, and scope; and 2) affective feature with affective languages such as praise, and criticism. Timms et al. (2015) studied the feedback model in the intelligent learning environment, which represents how learners notice, process, and understand feedback in the processing of feedback from cognitive psychology and neuroscience perspective.

RECOMMENDATION

In this study of critical peer feedback in EFL writing, critical thinking skills were explored in the process of higher-order peer feedback in order to facilitate higher-level writing. The Revised Bloom’s Taxonomy is accepted in critical peer feedback, which emphasizes the six steps of critical thinking. The critical peer feedback model has four steps including “intake”, “critical thinking”, “critical peer feedback output” and the “post-output”. This model is concluded in this qualitative case study; it cannot be used for generalization. However, it is valuable for the further study of critical peer feedback in other settings.

Many recommendations are given for further study. First, the concept of “critical peer feedback” may be explored from other aspects to understand “critical”, and to find other strategies for “critical peer feedback”. Even in the aspect of critical thinking, the strategy of “critical thinking” could be different from the Revised Bloom’s Taxonomy. Second, a quantitative study could be conducted to study the effectiveness of critical peer feedback. The quantitative study of the effectiveness is necessary for reliability, validity and generalization (Lincoln & Guba, 1985; Shenton, 2004). The effectiveness of critical peer feedback could be studied in any courses and cases by a quantitative study. Third, during the conduct of critical peer feedback, the rubrics of critical peer feedback could be further researched to study whether the peers’ critical peer
feedback are indeed critical peer feedback and could achieve the requirements of the critical peer feedback rubrics. Fourth, for modeling critical peer feedback, this study could be extended in other settings. The critical peer feedback model may be different in other settings such as different levels of education, different courses and different places.

REFERENCES


APPENDIX

INTERVIEW PROTOCOL FOR THE PARTICIPANTS

1. How do you understand critical thinking?
2. How do you understand critical peer feedback?
3. How do you use critical peer feedback in Business English Writing?
4. What are your focuses (or preferences) in offering critical peer feedback in Business English Writing?
5. How does critical peer feedback improve your quality of feedback in Business English Writing?
6. What are the advantages and disadvantages of critical peer feedback in Business English Writing?
7. What is your process of critical peer feedback?
8. What kinds or types of critical peer feedback are more helpful to your Business English writing?
9. What are your contents of critical peer feedback in Business English writing?
10. What are the factors affecting critical peer feedback in Business English writing?
11. Will you revise or rewrite your writing based on your peer’s feedback?
Examination Of Gifted Students’ Probability Problem Solving Process In Terms Of Mathematical Thinking

Serdal BALTACI [1]

ABSTRACT

It is a widely known fact that gifted students have different skills compared to their peers. However, to what extent gifted students use mathematical thinking skills during probability problem solving process emerges as a significant question. Thence, the main aim of the present study is to examine 8th grade gifted students’ probability problem-solving process related to daily life in terms of mathematical thinking skills. In this regard, a case study was used in the study. The participants of the study were six students at 8th grade (four girls and two boys) from the Science and Art Center. One of the purposeful sampling methods, maximum variation sampling was used for selecting the participants. Clinical interview and problems were used as a data collection tool. As a results of the study, it was determined that gifted students use reasoning and strategies skill, which is one of the mathematical thinking skills, mostly on the process of probability problem solving, and communication skills at least.

Keywords: Gifted students, Mathematical thinking skills, Probability.

INTRODUCTION

When we encounter uncertainty in positive sciences and in our daily lives, we are subject to using probability consciously or unconsciously, if required. This makes probability even more significant for individuals working in various professions (Hirsch & O’Donnell, 2001). Notwithstanding, probability which is a foremost concept is ascertained as one of the most problematic topics in terms of both students and teachers (Batanero & Serrano, 1999; Batanero, Serrano & Garfield, 1996; Dooren, Bock, Depaepe, Janssens & Vescamfa, 2003; Kafoussi, 2004; Munisamy & Doraisamy, 1998; Yildiz & Baltaci, 2015). The NCTM (2000) emphasized that students as conscious citizens and smart-consumers need to know probability topics with the aim of reasoning.

When examining the reasons for probability topics being hard to understand, Borovcnik and Kapadia (2009) identified that students answer the questions with intuition rather than logic while making sense of the probability concepts and thus face difficulty. Batanero, Chernoff, Engel, Lee, and Sánchez (2016) suggested that instead of understanding the topics, a large majority of the students try to memorize formulae and are unable to understand the questions. In addition, they have a negative attitude toward these concepts and do not use proper teaching materials. Carpenter, Corbitt, Kepner, Lindquist, and Reds (1981) stated that the lack of students’ prior knowledge and skills prevents effective learning of probability concepts. O’Connell (1999) also expressed that students make mistakes because of the conceptualism while solving probability problems. In order to resolve this sort of problems, several studies in the relevant literature emphasize adopting an experiment-based mindset of teaching, studying on stochastic events to help students apprehend the theoretical aspect of probability (Watson, 2006) and using student-centered approaches.
Aspinwall & Shaw, 2000; Gürbüz, 2008; Polaki, 2002; Tatsis, Kafoussi & Skoumpourdi, 2008). In addition, several institutions have stated that it is necessary to raise awareness about probability practices and it is important to use technology for developing conceptual understanding (Guidelines for assessment and instruction in statistics education, 2005; National Council of Teachers of Mathematics, 2000). According to Mills (2002) and Gürbüz (2008), difficulties in learning probability can be overcome using technology. Whether gifted students have these negativities or not, and if any what are the reasons are required to be answered in detail.

The concept of giftedness is defined by various educators and different parameters are explained. Experts define gifted children or students as those having high performance related to intelligence, creativity, art, or leadership capacity or specific academic areas in comparison to their peers (Kirk & Gallagher, 1989). The gifted are individuals differing in terms of the distribution of human characteristics, frequency, timing and composition (Akarsu, 2001; Meyen & Skrtic, 1988). Therefore, that gifted students’ qualitative and quantitative thinking skills are developed makes it possible for them to have better problem solving skills than the typical students (Knepper, Obrezut & Copeland, 1983) as problem solving does not solely mean to solve the easy tasks faced by individuals in daily life. Meanwhile, the highest cognitive functions such as analyzing, generalizing and synthesizing are used with regard to problem solving method (D’ Zurilla, Nezu & Maydeu-Olivers, 2004; Henson, 1993; Naglieri & Dass, 2005). Hence, solving problems fast as well as memorizing symbols, numbers and formulae are not to be considered as an indicator of mathematical giftedness (Wiseczankowski, Cropley & Prado, 2000). Mathematical thinking skills can be a criterion for mathematical giftedness.

As in Turkey, the development of students’ mathematical thinking skills among the overall objectives of mathematics teaching is emphasized in all countries (Keith, 2000; Mason, Burton & Stacey, 1998). Mathematical thinking can be summarized as a method of accessing from the known to the unknown which consists of making assumptions, gathering evidence and generalization processes regarding the cases (Baki, 2008). In order to participate actively in the mathematical thinking process, what is needed is to have mathematical thinking skills or develop them. Suzuki (1998) gathered these skills under five titles including conceptual knowledge, procedural knowledge, reasoning and strategies, maturity and communication.

Literature review shows that Suzuki’s mathematical thinking skills classification is more comprehensive and broad compared to that of other researchers. For instance; reasoning and strategies defined by Suzuki comprise guessing, association and persuasion – proof processes which are described by the other researchers. Thus, the skills identified by Suzuki are taken into account. These skills are described briefly as follows.

**Conceptual Knowledge:** Not only understanding the definition of the concepts but also mutual transitions and relations between the concepts are expressed (Baki, 2008). In other words, it is a skill including such features as understanding the problem statement, various meanings and the interpretations of the concepts as well as recognizing the problem with the unknown and equivalent quantities (Suzuki, 1998).

**Procedural Knowledge:** It includes strategies and methods necessary for implementing the concepts and principles (Taconis, Ferguson-Hessler & Broekkamp, 2001). In addition, Suzuki (1998) revealed that procedural skill includes such operations as making numerical operations and algorithms accurately, implementing the solution plans and controlling each action.

**Reasoning and Strategies:** This skill covers various behaviors such as demonstrating reasoning ability, selecting appropriate strategies, evaluating and interpreting the results and operations (Suzuki, 1998). On the other hand, Umay (2007) explained this ability as a process by which a rational decision is ensured taking into consideration all probabilities through evaluating the process with the knowledge available.

**Maturity:** Maturity is described as a skill including various behaviors such as organizing comprehensive solution strategies, changing the locution of the problem, and so forth in terms of knowledge development (Suzuki, 1998).

**Communication:** It is a skill which covers such behaviors as using mathematical language so that ideas can be transmitted as required, explaining the mathematical logic and reasoning for the solution process,
behavior as well as showing the connections between mathematical ideas (Suzuki, 1998).

The studies on the problem solving processes of gifted students generally focus on how gifted students at secondary schools solve the mathematical non-routine problems (Garofalo, 1993; Sriraman, 2003). Furthermore, most of the studies available in the literature said are quantitative studies (Suzuki, 1998; Tasdemir, 2008; Tuna, 2011). It has been found that how students use mathematical thinking skills while solving probability problems was not examined, although it is a widely known fact that gifted students have different skills compared to their peers. However, to what extent gifted students use mathematical thinking skills during probability problem solving process emerges as a significant question. Therefore, the main aim of the present study is to examine 8th grade gifted students’ probability problem-solving process related to daily life in terms of mathematical thinking skills. In this context, the research question is: “how do gifted students use mathematical thinking skills while solving probability problems related to daily life?”

**METHODOLOGY**

In this section; research method, participants of the study, application process, data collection and analysis are presented.

**Research Method**

A case study method was used in order to provide opportunity for examining a particular group in-depth and to examine data obtained from the data collection tools without any concern for generalization.

**Participants**

Gifted students are trained at the Science and Art Center which is a different educational institution independently from the school program (SAC) in Turkey. The selection process of gifted students who will be trained at these centers takes place in 6 stages which are classified as diagnosis, nomination, pre-assessment, group scanning, individual examination, registration and placement. These stages may indicate that Turkey attaches importance to the selection of gifted students.

In the current study, one of the purposeful sampling methods, maximum variation sampling was used in order to identify the participants. The aim of the maximum variation sampling is to create a small sample relatively and to reflect the individuals’ diversity to a maximum degree who will favor the research problem in this sample (Creswell, 2005; Johnson & Christensen, 2004). In this sense, the participants consist of six students at 8th grade continuing their education at Science and Art Center. Four of them are starting to train at Science and Arts at Center 6th grade have been getting education at this center for 3 years while two participants started there at 5th grade and have been taking education for 4 years. Four of the gifted students participating in the research are female students while two are male. It was paid utmost attention to selecting those who have higher problem-solving skills, are able to use GeoGebra software and volunteer for the interview, in accordance with teachers’ opinions.

Dynamic softwares provides a significant place in learning processes of students (Tatar, 2012). GeoGebra, which is one of the dynamic software, transfers mathematical symbols, graphics and obtained values to table via various Windows (Aktümen, Horzum, Yıldız & Ceylan, 2010). At the same time, GeoGebra dynamic mathematics software helps students display their high-level thinking skills (Edwards & Jones, 2006).

**Data Collection Tools**

Clinical interview and problems were used during the data collection process. Before the study was conducted, questions which can be asked during clinical interviews were determined. During the determination of the problems available in the data collection tool, their appropriateness to the level of students along with the demonstration of mathematical thinking skills in each problem was noted. The problems included dependent and independent probability and geometric probability topics. Accordingly, the problems included in the study were prepared by means of mathematics curriculum, math textbooks and books for teaching mathematics, then it was noted that the problems are approximately the same level with those taught at the Science and Art Center by discussing them with the mathematics teachers. Then, clinical interview questions and problems were independently evaluated by two experts. After this evaluation
process, evaluation reports were aggregated and discussed, and the final form of the interview questions and problems was created.

**Implementation Process**

Before starting the implementation, we conferred with three teachers working at the Science and Art Center and received information about how they teach probability there. They opined that gifted students learn the concept of probability principally at school. At the Science and Art Center, the teachers ask more strategy-requiring questions and provide students with a computer-aided environment to improve their reasoning. The teachers stated that they use GeoGebra in teaching probability concepts.

A pilot study was conducted with two gifted students with the purpose of identifying the flaws that may occur in the study. After the required arrangements following the pilot study, the original implementation was started. Thus, the problems included in the study were formed in the Appendix. During the implementation, asking the students probability problems respectively, their mathematical thinking skills were studied in-depth through clinical interview. During this process, environment was designed in such a way that students can use both paper – pen and GeoGebra software.

Before starting the clinical interview, the students and the researcher spent time together and the researcher informed them about the purpose of the research superficially. Each interview was recorded via a digital voice recorder with the permission of the students. The interviews were conducted individually and each lasted approximately 70 minutes. The interviews were carried out at guidance service which is a quiet area where the students feel unworried. Besides, during the interviews, the processes students did and the models were recorded on both GeoGebra screen and paper-pen environment associated with the students’ problems.

**Data Analysis**

Strauss and Corbin (1990) refer to three types through which qualitative data may be coded. These types of coding are: coding based on the predetermined concepts, coding depending on the concepts derived from the data, coding based on a general framework (Punch, 2013). In the study which takes into consideration Suzuki’s (1998) classification related to mathematical thinking skills and the definitions, coding based on the predetermined concepts was done. This coding emphasized findings section as conceptual knowledge (CK), procedural knowledge (PK), reasoning and strategies (RS), maturity (M), and communication (C). On the other hand, while forming frequency tables presented at the end of each problem, Suzuki (1998) mathematical thinking skills were paid attention and the sum total was noted.

Prior to data analysis, data base dump and control were enacted. Each interview was noted by paying attention to the interviewer-interviewee written order, phonetically and without any correction. Next, the themes were separately developed by the researcher and a field expert. Therefore, the related information was given to a field expert, too. To shape the analysis part into final form, the independent series of analysis was brought together and discussed. This was a necessary process to provide the validity of the study. Thus, how gifted students demonstrate each skill during probability problem solving process was identified in detail. Intercoder reliability was 95%. Moreover, various codes were used while the findings were presented. In this context; A refers to a researcher and G1 signifies gifted students 1 ...and so forth.

**FINDINGS**

In this section, 8th grade gifted students’ mathematical thinking skills used for solving probability problems related to their daily lives were analyzed. The results were supported via direct quotes from the clinical interview, the solutions students found and the models on GeoGebra screen. Thus, the findings were identified as follows:

**The findings related to the first problem solving process:**

It was found that all of the gifted students stated the problem with their own words, and then they tried to express their ideas about solving the problem by putting forward the given and required. For instance, G1 stated that a circle tangent to the two opposite sides is drawn inside a rectangle the perimeter
of which is 24 units and expressed that she wants to find the probability of hitting the arrow outside the circle by determining the given and the required.

G1: The problem is about taking a quadrilateral and a circle tangent to the two sides of this quadrilateral. However, we are expected to hit the arrow outside the circle.

A: Yes. What can we do?

G1: Now, we should have a quadrilateral whose perimeter is 24 units. We will draw a circle inside this quadrilateral which is tangent to the two opposite sides. Then, we will calculate the probability of hitting outside the circle. I think the given and the required related to the problem are in this way.

A: OK. Let’s continue.

G1: And here quadrilateral must be special. It can be a square.

As observed above, G1 tried to explain the problem with her own words by determining the given and the required and decided to start from square a particular case in order to solve the problem (CK). This shows the understanding of the problem statement which is an indicator of the conceptual knowledge. Afterwards, all of the gifted students who think that the target is a square organized the instructions presented for the problem solving; besides, they modeled the required in the paper and pencil environment. Thinking that the model that he created in this process is correct, G3 has tried to solve the problem as follows.

G3: If the target was a square, the diameter of the circle that we will draw inside it would be 6 units. If the selected point was inside, the required probability would be $9\pi / 36$; we get the result when we subtract it from 1.

A: So is this our result?

G3: Here our global cluster, all the results, is the area of the square and the outside of the circle is the required. Actually, it is like throwing money experiment. So all the results are tail or head. If head is required, then we divide one situation into two, which is also observed here. But there is only one situation that is Geometric. In fact, the probability of 3 out of 4 hits related to the probability of being inside is $\frac{3}{4}$ while the probability of being outside 1 out of 4 hits is $\frac{1}{4}$. The result is shaded area / the entire area = $\frac{1}{4}$. When we get 3 instead of $\pi$, as the area of the circle will be 36, the probability of being inside would be $27 / 36$. We can find the result when we subtract it from 1.

![FIG. 1. A section related to the solution of G3 student in the event of a square target](image)

As is observed from the figures and interview data, G3 tried to do the processes with self-confidence which means that he achieved the solution fast through practicing (PK; M). Moreover, G3 conveyed the ideas as required through giving an example related to the solving process, thus having an effort to use mathematical language (C). Hence, he rationalized the problem by modifying the expression of the problem (M). Trying to check the accuracy of what she did, G2 stated that she can control the result by solving it again
without GeoGebra software; however, the other five gifted students wanted to check the result via GeoGebra software. An example representing the processes conducted by G5 on software is as follows.

**FIG. 2. G5’s checking process of the result on software in case of a square target**

As seen in Fig. 2, G5 tried to check the result he found via software (RS). During this process, G5 expressed the roundings done in the paper and pen environment on the screen and made an effort to do the processes by means of software using mathematical language (PC). As a result, following the process presented above as a section, all the gifted students found the correct result in case of a square target. Thereafter, when it comes to a rectangle target, it was clarified that the majority of the gifted students reached the solution through generalizing the required probability mathematically (CK). Ultimately, all the gifted students managed to find the result in the event of a rectangle target. The figure drawn by G4 to express the required probability in general is as follows:

**FIG. 3. A section related to G4’s generalization the required probability mathematically in case of a rectangular target**

Subsequently, G4 determined the edges of a rectangle as 4 and 8 units and tried to explain the result as follows (PK). Given the process followed above, it was revealed that G4 did the processes in a meaningful
way in case of a rectangle target (CK), announced these expressions through using a mathematical language (PK; C), reflected her reasoning ability for choosing the appropriate strategy and got the result in a systematic way (RS; M). Having tried to present the accuracy of the result in case of a target square, gifted students stated that they are sure of what they did in case of a rectangle target (RS; C).

In the event of a square and rectangle target, some of the successful gifted students did not achieve the same success in the paper and pen environment as in the case of a parallelogram target. In fact, it is hard to find the required probability for the parallelogram target. However, four of the gifted students were successful in solving this problem. As the students who are successful, G2 also found the height of the parallelogram with a special value in the paper and pen environment and found the correct result (CK; PK). This process is as follows.

As considered above, the gifted students got a specific triangle with the aim of finding the height of the parallelogram gives us clues regarding their way of thinking. On the other hand, unlike the other two students who solved the problem successfully, G6 generally expressed the edges of parallelogram and generalized the required probability mathematically based upon these data (CK; PK; M). Thereafter, G6 forming the required on GeoGebra screen found the height through taking different numbers for the edges of parallelogram and noted her findings in the paper and pen environment (M; C). The dialogs and figures related to this process are as follows.

G6: If we get the edges of it as a and b, the probability of being inside is $\pi r/(2b)$ when the radius of the circle is r, the area of it is $\pi r^2$ and the area of parallelogram is $2r.a$. I find the required result while subtracting it from 1. Yet, I cannot find the height when I consider the edges of parallelogram as 4 and 8 units, but I can achieve the required through GeoGebra.

FIG. 5. A section of G6’s generalization and modeling on software the required probability in case of a parallelogram.
Within the scope of the present study the aim is to examine gifted students’ mathematical thinking skills during the probability problem solving process, the frequency table presented as Table 1 shows how many times each student uses mathematical thinking skills during every interview process regarding all the problems.

**Table 1. Frequency Table Related to The First Problem**

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual Knowledge (CK)</td>
<td>18</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>18</td>
<td>18</td>
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<tr>
<td>Procedural Knowledge (PK)</td>
<td>16</td>
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<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Reasoning and Strategies (RS)</td>
<td>19</td>
<td>18</td>
<td>18</td>
<td>19</td>
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<td>20</td>
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<tr>
<td>Maturity (M)</td>
<td>14</td>
<td>15</td>
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<td>17</td>
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<tr>
<td>Communication (C)</td>
<td>13</td>
<td>14</td>
<td>14</td>
<td>15</td>
<td>13</td>
<td>14</td>
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</tbody>
</table>

When Table 1 is examined, it was observed that the reasoning and strategies are mostly used in this process, which is followed by conceptual knowledge communication skills. The first problem is seen as much more difficult perhaps because: geometric probability and the background knowledge required for the problem is quite substantial.

**The findings related to the second problem solving process:**

All the gifted students were able to easily understand that the problem is a probability problem. Afterwards, students entered in the process of problem solving, making comments about which type of probability is asked related to the problem (CK; M). In this process, the dialog between the researcher and G1 is as follows.

_G1:_ The probability that Ali hit is 40%, 2/5 while that of Veli’s hitting is 75%, ¾. The probability of being hit by both of them and by one of them is required. It refers to an independent situation as their hitting the target does not affect each other. Thus, the answer of the option a is 6/20.

_A:_ Why? Where did you get this answer?

_G1:_ What is required is the hitting of both. That is why, I multiply their hitting probabilities. For instance, two persons throw the coins and both of them are heads.

As is seen, explaining that the problem is about the probability topic, G1 expressed the solution correctly (CK; M). In fact, G1 tried to explain the solution in another way through mathematical reasoning (C). In addition, as shown in the example a section of which is presented, the fact that all of the gifted students refer the problem as the probability problem gives us various clues concerning their success in problem-solving strategies.

Thereon, of all the gifted students trying to figure out the probability of being hit by only one, G3 was unable to state the required probability at first (CK) whereas the others did not have difficulty in finding the probability. In this process, G3 tried to find the result by adding up hitting probability of them and vice versa, then got the result realizing his mistake. This process is as following:
FIG. 6. A section of the probability problem where G3 did wrong in calculating the required probability

G3: I did wrong here. One will hit while the other will not so the result is \( \frac{2}{5} \cdot \frac{3}{4} + \frac{3}{5} \cdot \frac{3}{4} = \frac{11}{20} \).

G3 found the false result without understanding the problem through adding up hitting probability of both and vice versa (CK; PK). Following, being aware of the mistake he made, G3 was able to find hitting probability of one (RS).

Table 2. Frequency Table Related to The Second Problem

<table>
<thead>
<tr>
<th>Conceptual Knowledge (CK)</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
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<td>11</td>
<td>12</td>
<td>13</td>
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</tr>
<tr>
<td>Procedural Knowledge (PK)</td>
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<tr>
<td>Reasoning and Strategies (RS)</td>
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<td>12</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Maturity (M)</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Communication (C)</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

It was revealed that conceptual knowledge is mostly used in this process, which is followed by reasoning and strategies and communication skills. The greater use of conceptual knowledge may be because they expressed the given problems related to daily life as probability problems and carry out the processes in a meaningful way.

The findings related to the third problem solving process:

As for the other problem, the students are inclined to solve the problem as immediately as possible. To illustrate, G5 stated he encountered such a problem before and was able to find the solution as follows. The dialog and the solution found by G5 are as follows:

G5: Actually, I encountered with this kind of problem before. Here we’ll draw a white ball from bag A and put it into bag B. When we draw a ball from bag B, we want it to be a white ball.

A: OK. How were the problems you have encountered before?

G5: It was almost the same; that is there was a bag and we draw a ball.

A: Well, how will you do it?

G5: The probability of drawing a white ball from bag A is 3/7. If we put it into bag B, then the probability of drawing white will be 3/6-1/2 as 6 balls are available. Similarly, if we draw black from bag A, the probability will be 4/7. When we put it into bag B, the probability of drawing 2 white balls out of 6 will be 2/6-1/3. Hence, the required probability will be 3/14 + 4/21.
When the dialog between G5 and the researcher along with the student’s solution are examined, G5 was found to easily understand the problem and started to solve it by detailing in a systematic way (CK; M). Likewise, G5 was observed to conduct the processes in an efficient manner as well as expressing ideas as necessary through using mathematical language (PK; C). The fact that gifted students expressed their ideas using mathematical language reveals the differences in their solutions.

In the process, G4 drew a figure like a probability tree, which is an example of a different strategy (M). The solving process of G4 is as the following.

As seen in Fig. 8, G4 tried to use a different problem-solving strategy (M). It may be natural for gifted students to have different thinking styles.

The majority of gifted students who are sure about the solutions they found were not involved in the process of controlling the obtained results (RS). For instance, the dialog between G6 and the researcher after finding the correct result is as follows.

_A: Did you think that the result I have found is accurate? How can you prove?_  
_G6: I think it is correct. I’m sure what I did._
Table 3. Frequency Table Related to The Third Problem

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<th>G1</th>
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<th>G4</th>
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<tr>
<td>Procedural Knowledge (PK)</td>
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<tr>
<td>Reasoning and Strategies (RS)</td>
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<td>8</td>
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<tr>
<td>Maturity (M)</td>
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<td>8</td>
</tr>
<tr>
<td>Communication (C)</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>4</td>
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</table>

As for the third problem, it was revealed that operational knowledge is mostly used in this process, which is followed by reasoning and strategies and communication skills. Operational skill is at the forefront in terms of the third problem since it is likely that gifted students stated their encounter with these types of problems and did the processes efficiently. The less use of communication skills shows that gifted students focused on the solving process the minute that the problem is presented. Taking into account all these mathematical thinking skills, a frequency table is created (Fig. 9).

![Mathematical Thinking Skills]

**FIG. 9. The frequencies of gifted students’ demonstration of mathematical thinking skills for each problem**

**DISCUSSION**

It was found that all of the gifted students stated the problem in their own words, and then tried to express their ideas about solving the problem by putting forward the given and required. Mayer (1982) indicated that the most difficult stage of the problem for students is the understanding process. Gifted students are good at expressing the problem depending upon their own way of thinking. In parallel to the findings of the research, Garofalo (1993) and Sriraman (2003) signified that the gifted students succeeded in interpreting the problem with their own sentences, yet they wasted time during this process. This situation is an indicator of conceptual knowledge as the students’ effort to understand the problems deeply. A gifted student who is willing to solve the problem correctly is supposed to understand the problem, try various ways and reach the solution.

It has been determined within the scope of the studies that the use of dynamic software by the students will benefit them when they do mathematical generalizations (Balca & Yildiz, 2015; Cha & Noss, 2001; Santos-Trigo & Cristóbal-Escalante, 2008). In the current study, it was pointed out that gifted students want to do the processes through qualitative detailing and thus have differences in terms of their thinking skills. On the other hand, all the gifted students were able to associate the second problem with the probability topic. Therefore, of all the skills, conceptual knowledge is the most demonstrated one by the gifted students related to the second problem. It is emphasized that students make associations in today’s mathematics education programs (Chapman, 2012; NCTM, 2000). As in the present study, Putter-Smits, Takonis and Jochems (2013) and Rose (2012) determined that presenting the problems through associating
them with daily life is to be effective in the students’ understanding.

Considering operational knowledge skill, it was shown that gifted students did operations with full self-confidence and observed the rounding done in paper-pen environment on software screen easily. Besides, it was observed that gifted students generalized the required probability value mathematically and then reached the result by numbering the equation differently especially in terms of geometric probability problems. Students applied computational operations and algorithms easily to the mathematically generalized equations. Moreover, the gifted students tended to solve the third problem. Stating that s/he encountered with a similar problem before, one of the students initiated the solving process, which has led the gifted students to use operational knowledge mostly. Yesildere and Turnuklu (2007) also made it clear that students are much more successful regarding operational problems which might use the knowledge directly rather than those using reasoning skills.

When it comes to the reasoning skills and strategies, it was emphasized that gifted students could not only interpret but also evaluate the processes they conducted as well as the results they found as analytical and algebraic through algebra screen thanks to the graphic display of the GeoGebra software. Baki, Yildiz and Baltaci (2012) state that GeoGebra dynamic mathematics software that provides functionally different displays on the same window is a key for the emergence of this finding.

Ensuring that they solve the second and the third problems correctly, the gifted students did not have a tendency for controlling the results obtained by identifying the appropriate strategies. Indeed, Lester, Garofalo, and Kroll (1989) also observed that the gifted students who carried out a successful plan during the problem-solving process did not control the results. Further, Pajares (1996) stated that gifted students had more self-efficacy beliefs while solving the problems. However, Yildiz, Baltaci and Guven (2011) determined that gifted students were unwilling to check the accuracy of the results after solving the problems. As the gifted students have self-confidence in preparing a good plan for any problem they encountered, they are not eager for illustrating the accuracy of the results. Thus, it is essential that students are required to prepare a good plan before providing them for doing crosschecking.

As for the maturity skills, all of the gifted students organized the instructions presented for the problem solving; besides, they modeled the required in the paper and pencil environment. The fact that gifted students solve the problems by drawing figures thus achieving the solutions easily is in parallel to the finding by Hong (1993) about the expression of the problem much better through creating models. As for the first problem, it is emphasized that the majority of the gifted students succeeded in the case of square and rectangle target get a specific triangle so as to find the edges of the parallelogram and found its height. Similarly, Shore and Dover (1987) stated that the thinking processes of gifted students are different from the others. For example, that the gifted students got a specific triangle with the aim of finding the height of the parallelogram gives us clues regarding their way of thinking.

It is clear that gifted students understand the problems easily and initiated the solving process detailing it in a systematic manner. Congruent with the findings of Montague, Bos and Doucette (1991), gifted students solved the problem as soon as they encountered it. Sisk (1987) also confirmed that gifted students are to choose the appropriate strategy and make original comments based upon the problem. Still, to solve the problem fast and to memorize symbols, numbers and mathematical formulas are not being considered as an indicator of giftedness (Wieczerkowski, Cropley, & Prado, 2000).

Considering the communication skills, it was ascertained that gifted students are able to use mathematical language easily while solving the problems and transferring thoughts. Cai (2003) determined that gifted students chose appropriate solving strategies and used an open communication style which represents the solutions selected during the solving process. That gifted students use mathematical language easily while transferring their thoughts shows their skill for expressing ideas mathematically as well. Accordingly, teachers are required to prepare a well-designed learning environment so that students can develop the use of mathematical language skills. As a reference to the learning environments, teachers should evoke the students’ metacognition in problem solving environments as in Yildiz (2013).

In the present study, gifted students’ mathematical thinking skills during probability problem solving process were observed. As discussed before, gifted students have been found to have different behaviors
related to the skills in this process. Thus, teachers who want to provide a more efficient lesson environment can determine students’ mathematical thinking skills in a better way and use GeoGebra software as a tool.

REFERENCES


APPENDIX

Problems Used in the Research

1. **Problem:** Ali’s father forms a dart board by drawing a rectangle whose perimeter is 24 units and a circle tangent to the two sides of this rectangle. Ali’s father gives darts arrows to Ali wants him to hit the thrown arrow to the dart board. Meanwhile, assuming that Ali hits the dart board, Ali’s father tries to calculate the probability of arrow’s hitting outside the circle with his mathematical knowledge.

   Please guide Ali’s father through using the following quadrilaterals?
   a. For square;
   b. For rectangle;
   c. For parallelogram

2. **Problem:** Ali and Veli play that game when they have free time. In this game, both of them try to hit the target they determined from the same distance. Ali hits the target 40 times out of an average 100 shots while Veli hits 75 times out of an average 100 shots.

   When Ali and Veli hit the target;
   Calculate,
   a. the probability of being hit by both
   b. the probability of being hit by one?

3. **Problem:** Mehmet who named the bags as A and B puts 3 white and 4 black balls in bag A while 2 white 3 black balls in bag B. Then, he wants Akif to draw a ball from bag A, put it in bag B and draw a ball form bag B. What is the probability that the white ball drawn from bag B by Akif?
Relationship Between Teacher ICT Competency And Teacher Acceptance And Use Of School Management System (SMS)

Leong Mei Wei[1], Chua Yan Piaw [2], Sathiamoorthy Kannan [1], Shafinaz A. Moulod [4]

ABSTRACT

This study aims at examining the relationship between teacher ICT competency and teacher acceptance and use of SMS in Negeri Sembilan secondary schools in Malaysia. This is a non-experimental quantitative research using survey technique through the administration of a set of questionnaire that comprised teacher demographic variables, teacher ICT competency and teacher acceptance and use of SMS. Some 417 returned questionnaires have been analyzed. The findings showed that teachers in Negeri Sembilan secondary schools rated themselves as having high level of ICT competency, and acceptance and use of SMS. Furthermore, data indicated that there was a statistically significant moderately strong positive correlation between teacher ICT competency and teacher acceptance and use of SMS. In addition, multiple regression analysis showed that smart pedagogy, professional growth and leadership, and digital citizenship were the three teacher ICT competency dimensions that are statistically significant predictors of teacher acceptance and use of SMS. The fitness indexes of the proposed structural model do not achieve the level of fitness required for RMSEA, GFI, and Ratio Chisq/df. Thus, a re-specified structural model was established for this study.

Keywords: ICT Competency, ICT Acceptance, ICT Use

INTRODUCTION

Globalization and the advancement of information and communications technology (ICT) have created a new knowledge-driven economy era and brought intense competitiveness in the workplace (Haughey, 2006). Consequently, many governments have started to invest heavily in ICT to address the demands of this digital information age (Ministry of Education Malaysia, 2010). The progress of web-based technology together with the exponential growth of Internet accessibility has enabled widespread usage of web-based applications across many different disciplines (Avci Yucel & Gulbahar, 2013). The prominent role of ICT could be seen in advancing knowledge and as a necessary skill for effective functioning in the modern world (Adeyemi & Olaleye, 2010; Trilling & Fadel, 2009). Hence, the educated workforce is vital to remain competitive because the state of the education system today is the best predictor of Malaysia’s competitiveness tomorrow (Ministry of Education Malaysia, 2013b).

Educational technology has altered the instructional landscape (Papa, 2011) and significantly changed the Malaysian educational system (Wong, Mas Nida, Abu Daud, & Othman, 2011). In 1996, the Malaysian government launched the Multimedia Super Corridor (MSC) to accelerate its entry into the Information Age as the major national initiative to transform Malaysia into a knowledge-based society with ICT advancement.
in line with the country’s ambitions in achieving fully developed status by 2020. Smart School, one of the seven flagships under the MSC aimed at integrating ICT into the school environment to equip the next generation to become more competitive in the technology-driven globalized world (Hamsha, 2011). Now, the new ‘ICT in Education’ concept has a broader notion and it operates in a grander scheme as compared to the ‘Smart School’ initiative. The broader concept includes amalgamating multilateral efforts from all stakeholders, from the Ministry of Education (MOE) level to the school and educational institution level, and especially the Community of Practice which consists of experienced teachers, industry practitioners, alumni, parents and students who can provide constructive feedback on user requirements and areas of improvement to solidify the approach of integrating ICT in education (Ministry of Education Malaysia, 2010). MSC Malaysia would identify and support the development of niche areas in software and e-solutions, creative multimedia, shared services, outsourcing and e-business in the 10th Malaysia Plan 2011–2015 (The Economic Planning Unit of Prime Minister’s Department, 2010).

Moreover, the Interim Strategic Plan 2011-2020 (Ministry of Education Malaysia, 2012b), also strongly emphasized ICT use in schools or educational institutions as a prerequisite for Malaysia to become a high income nation to achieve the 10th Malaysia Plan 2011-2015 objectives. To achieve the objectives mentioned, MOE has launched a comprehensive education system review in order to develop a new National Education Blueprint in October 2011 (Ministry of Education Malaysia, 2012a). The Blueprint offers a vision of education system and students’ aspirations that Malaysia both needs and deserves, and 11 strategic or operational shifts required to achieve that vision have been suggested. Among these 11 strategic shifts, shift seven is related to the leverage of Information and Communications Technology (ICT) to scale up quality of learning across Malaysia which provides Internet access and virtual learning environment via 1-BestariNet for all 10,000 schools. Furthermore, Clause 29 & 30 in the National Education Policy effort from the Educational Policy Planning and Research Division (2012) also clearly reflected the needs of the educational system in Malaysia to use ICT in teaching and learning and educational management.

School systems have access to more data than ever before but most teachers and school leaders are lacking in skills to use the data for student and school improvement (Murray, 2013). Hussein (2013) stated that there appears to be lack of coordination among Malaysian educational agencies that routinely collect some amount of the same school-related information. This practice has tended to create duplication in data collection, raising issues of questionable data reliability and extra burden to schools. Thus, he suggests that a more comprehensive, detailed and related information system that can digest, assimilate, interpret and use with full effectiveness is necessary to overcome this weakness. Besides, the information system should highlight integration of management, administration and operations that will be required in terms of the principal alliances and the channels of communication across divisions and units, states, districts and schools. His suggestion is in line with one of the eight key focus area covered under the Policy on ICT in Education (Ministry of Education Malaysia, 2010) to have a central Educational Management System.

Following this, a new School Management System (SMS) was launched by the Education Technology Division, Ministry of Education in 2013. SMS is a simplified and resourcefully integrated system with can accomplish many management tasks (Haslina, Bahbibi, & Norhisham, 2014). The main objective of this system is to create only one information management application for all schools to reduce teachers’ burden and to create a centralized database that can be utilized and reached by multiple users or all agencies under the MOE. This system automates two key function areas which are: (i) school management and educational administration and (ii) teaching and learning (Ministry of Education Malaysia, 2013a). School administrators and teachers used the SMS to manage schools’ information, whereas, at the same time parents, Ministry of Education staff and even students can access relevant information from the SMS.

According to Madiha Shah (2014), the online information system usage in educational management has increased rapidly due to its effectiveness and efficiency; the main purpose and usage of school management system was to improve the efficiency of school activities in terms of storing students’ and teachers’ personnel data. Furthermore, the overall literature review highlighted the positive impact of school management system on school management and administration which includes more efficient administration, better time management, higher utilization of school resources, reduction in workload, better accessibility to information, and improvement in the quality of reports. Thus, technology includes all scientific techniques and processes for improving work and to be an effective user of technology, it is
important for the school teachers to understand how technological advances could affect the effectiveness of school management (Munro, 2008). In other words, teachers are the driving force to ensure effective utilization of SMS in school management. However, teachers need to have the necessary skills or competencies to perform this task. Hence, this study was carried out to examine the relationship between teacher ICT competency and teacher acceptance and use of SMS in Negeri Sembilan secondary schools.

**PROBLEM STATEMENT**

Mounting pressure from other sectors to produce computer-literate graduates, and fear that our students will be ill prepared for participating in the knowledge-based economy without good computer skills, is pushing the Malaysian government to invest more heavily in computer technology over the five decades since independence (Ministry of Education Malaysia, 2012a). However, the gap between the high levels of expenditure on educational technology and the expected return in school improvement is still a global education agenda with great debate (Leong, 2010; Lu, 2013; Wahdain & Ahmad, 2014). Moreover, continuous efforts are being taken to enhance teachers’ ICT skill in all schools in the Malaysian context (Sathiamoorthy, Leong, & Mohd Jamil, 2011), but the ICT usage in schools does not meet the expected requirement both in terms of quantity and quality (Fong, Ch'ng, & Por, 2013). This indicates that the investment and policies in getting teachers to embed the use of ICT have not yet been found to be helpful by teachers (Haydn & Barton, 2008).

Chen (2004) and Wachira and Keengwe (2011) found that despite the proliferation of computer equipment provided in the school and the promise of educational technologies, survey of teachers consistently showed declines in educational technology usage. Based on a MOE study finding in 2010, only one third of students perceive their teachers to be using ICT regularly in their teaching process and about 80% of teachers are found to spend less than one hour a week using ICT even though ICT has tremendous potential to accelerate the learning process. However, this potential has not yet been achieved (Ministry of Education Malaysia, 2012a).

Furthermore, based on the Feedback on The Auditor General’s Report 2013, Series 3 (Ministry of Finance, 2014), the level of Virtual Learning Environment (VLE) usage among Malaysian teachers is very low, in the range of 0.57% to 4.69%. This issue of low and slow uptake of technology among teachers brings us to one very pertinent question: What can be done to ensure that teachers do and want to accept and use technology in carrying out their routine duties as teachers?

Liew (2007) found that most teachers may not be in favor of the ICT program because they lack competency in dealing with ICT. Is this the main cause of low level of ICT usage among teachers? According to Hamsha (2011), adopting ICT competency standards and adequate training will help teachers to incorporate ICT effectively in education. Besides, it is also commonly acknowledged that ICT is expanding rapidly; if teachers are not ready with adequate and latest knowledge and skills, they would be unable to keep pace with the ever-changing technology and inevitably will be left behind and hampered from mastering new ICT competencies (Mas Nida, Wong, & Ayub, 2011). Hence, a paradigm shift needed to maximize the potential of ICT and its application is very much expected in the minds of the teachers and the concerned authority that is in charge of preparing the teachers to keep abreast of rapid ICT development (Sathiamoorthy et al., 2011). So, in order to prepare teachers to use technology effectively, we need to identify the current level of teacher ICT competency; in other words, how teachers perceived their own ICT competency.

Even though ICT usage has been proven able to improve organizational effectiveness and productivity, the human factor is identified as the most important determinant for the success or failure of ICT implementation (Wahdain & Ahmad, 2014). Besides teacher ICT competency, teacher acceptance and use of ICT are another vital elements (Ministry of Education Malaysia, 2010). Information system has played a significant role in education management, but resistance to its usage by public school teachers worldwide remains high (Hu, Clark, & Ma, 2003). Liew (2007) assumed that one of the main factors that might hinder ICT program implementation could be teachers’ resistance to the acceptance and use of this new technology in school and this will cause the huge investment into SMS development to be wasted. So, in order to properly and effectively implement SMS in our public school system, teachers need to have positive attitudes and confidence in using this SMS that will motivate them to integrate it into their routine work. In other words, teachers’ attitudes and beliefs about SMS usage will significantly influence their acceptance and use of SMS.
in their routine work. Thus, it is important to study teachers’ level of acceptance and use of SMS to ensure efficient and effective school management in Negeri Sembilan. Furthermore, the researcher aims to examine the relationship between teacher ICT competency and teacher acceptance and use of SMS in Negeri Sembilan secondary schools.

RESEARCH OBJECTIVES

This study aims at investigating teachers’ perception of their level of ICT competency and acceptance and use of SMS in Negeri Sembilan secondary schools. The objectives of this study are as follows:

1. To analyze the level of teacher acceptance and use of SMS (endogenous variable) in Negeri Sembilan secondary schools.
2. To analyze the level of teacher ICT competency (exogenous variable) in Negeri Sembilan secondary schools.
3. To examine the relationship between teacher ICT competency and teacher acceptance and use of SMS in Negeri Sembilan secondary schools
4. To analyze which of the teacher ICT competency dimensions are the significant predictors of teacher acceptance and use of SMS in Negeri Sembilan secondary schools.
5. To evaluate if the proposed structural model involving teacher ICT competency and teacher Acceptance and use of SMS fit with the data collected from Negeri Sembilan secondary schools.

CONCEPTUAL FRAMEWORK

This study investigates teacher ICT competency as the endogenous (dependent) variable in relation to teacher acceptance and use of SMS as the exogenous (independent) variable. The formulation of the conceptual framework for this study was based on Vroom’s (1964, 1995) expectancy motivation theory that motivation is a product of the individual’s expectancy that a certain effort will lead to the intended performance. This was further supported by Parijat and Bagga (2014) who stated that motivation is the driving force behind all human efforts and it is essential to their performance. Hence, as applied to this study, this theory holds that if teachers possess ICT competency as their effort to perform any task by using the SMS, teachers will be motivated to accept and use SMS to carry out their routine work. The conceptual framework of the study are as shown in Figure 1.

EXOGENEOUS VARIABLE
Teacher ICT Competency: (ISTE Standard.T)
1. Visionary leadership
2. Digital age learning culture
3. Excellence in professional practice
4. Systemic improvement
5. Digital citizenship

ENDOGENEOUS VARIABLE
Teacher Acceptance and Use of SMS: (UTAUT2)
1. Performance Expectancy
2. Effort Expectancy
3. Social Influence
4. Facilitating Conditions
5. Hedonic Motivation
6. Habit

Figure 1. Conceptual framework of the study.

LITERATURE REVIEW

Teacher ICT competency has been viewed as a prerequisite for the acceptance and use of ICT in school systems (Archibong, Ogbiji, & Anijaobi-Idem, 2010). According to Rogers (2003), individuals’ decision to accept and use a new technology is related to the skills and knowledge one has regarding how to operate that technology (information system) appropriately. Based on the Jegede, Dibu-Orjerinde, and Illori (2007)
empirical study, the finding indicated that there was a significant positive relationship ($r = .663, p < .05$) between ICT competence and the general computer attitudes and practices of an individual.

In line with the Jegede et al. (2007) study, Sa’ari, Wong, and Roslan (2005a) also found that teachers who demonstrated high level of competency in using computers find information systems to be more useful. These teachers approached the information system with greater confidence and displayed a lower level of anxiety and aversion to using it. Besides, the results showed that there was a weak positive correlation ($r = .127, p < .05$) between teachers’ attitudes and their perceived competence toward computer usage (Sa’ari, Wong, & Roslan, 2005b). Therefore, the researchers argued that being competent in using computers is also an important asset rather than only having positive attitudes toward information system usage. This showed that both attitudes and ICT competency played a significant part in establishing the concrete development of teacher acceptance and use of information system. In other words, to enhance teacher acceptance and information system use, there is an urgent need for the teachers to acquire the right attitude with a higher competency level for the betterment of the information system application in the education system.

Based on another study conducted by Ting (2007) to investigate the level of ICT usage among 181 teachers from four secondary schools in the Sarikie District, Sarawak, Malaysia, the researcher found a moderate significant positive correlation ($r = .42, p < .01$) between teacher ICT competency with teacher’s level of ICT usage. This positive relationship revealed that teachers with a higher level of ICT competency will demonstrate a higher level of ICT application.

Next, another study conducted by Lau and Sim (2008) further clarified that teachers who are more competent in using ICT have reported more favorable perception toward the acceptance and ICT use in Malaysian secondary schools. Hence, the authors suggested that to develop their ICT competency teachers’ perception must change and their ICT usage must increase. This result is consistent with the findings of the previous study which concluded that teachers who are more competent in using computers also have more favorable attitudes toward computers (Jegede et al., 2007; Sa’ari et al., 2005b; Varol, 2013).

Afshari, Kamariah, Wong, Foo, and Bahaman (2009) took the final data of 320 Iranian secondary school principals to examine the extent to which they used computers, their perceived computer competency and leadership styles. The study findings showed that principals’ computer competence and transformational leadership contributed significantly to their level of computer use. The Pearson product-moment correlation coefficient showed a significant positive strong relationship between their level of computer use with their computer competency ($r = .74, p < .05$). This finding implies that level of computer use would be improved when computer use competency were enhanced. In other words, the higher level of computer use is often caused by an increase in computer competence. Furthermore, the strong, positive relationship between computer use and computer competence suggests that establishing regular programs for improving principals’ competence would help to improve their level of computer use for instructional and administrative purposes. Computer competence explained 54% of the variance in the level of computer use. This finding made computer competence an important factor that can be taken into consideration when examining the level of computer use.

Integration of ICT into classroom instruction for meaningful learning has been a challenging task worldwide (Chai, 2010). Chai (2010) conducted a study to investigate the relationships among Singaporean pre-service teachers’ ICT competencies, pedagogical beliefs, and their beliefs about ICT acceptance and use. The data were collected from 1,230 pre-service teachers who enrolled in teacher preparation programs at the National Institute of Education, which is the sole teacher education institute in Singapore. The findings affirmed that the pre-service teachers’ ICT competencies and their pedagogical beliefs are significantly related to their acceptance and use of ICT. These findings suggested that basic ICT competencies underpin teachers’ ICT use in their instruction. However, based on the path analysis, pedagogy-oriented ICT competency does not yield any significant paths toward ICT use. The researcher found that this might be because the construct is targeted toward general pedagogy such as classroom management and the adaptation of existing electronic resources for teaching. Hence, he suggested that a more specific survey related to a clear theoretical orientation should be further explored.

Based on the NETS.T (2000) performance indicators prescribed by ISTE, Hsu (2010) developed two scales to measure teachers’ self-perceived technology integration competency and usage. The data were
collected from 3,729 Taiwanese teachers. The results of Pearson correlation showed a significant moderate positive correlation ($r = .56, p < .001$) between teachers’ technology integration competency and usage. This finding suggests that teachers with high competency in technology integration generally show higher usage of technology integration in their daily work.

Based on a survey conducted by Buabeng-Andoh (2012a) to examine teachers’ competency, perceptions, and practices toward ICT usage in second-cycle institutions in Ghana, the correlation analysis showed a positive significant correlation ($r = .68, p < .01$) between teachers’ ICT use and their ICT competence. This result is consistent with Sorgo, Verckovnik, and Kocijancic (2010), who found a high correlation between teacher ICT competency with the frequency of use of ICT and perceived importance of ICT among Biology teachers. They concluded that teacher ICT competency and confidence were predictors of ICT usage in teaching.

In contrast, Drent and Meelissen (2008) found that teachers’ ICT competence has no direct influence on their innovative ICT usage. However, we found that the teachers’ ICT competence defined by these researchers is only the basic computer skills and knowledge regarding how to operate the computer and software; it was more appropriate to focus on the end-user ability to apply ICT in carrying out routine tasks. Hence, in this study, we aim at studying teacher ICT competency in terms of skill and knowledge as an educator in teaching, working and learning processes based on the ISTE Standard.T (2008).

Based on the literature discussed, the majority of studies reported a significant relationship between teacher ICT competency with teachers’ application or acceptance and use of ICT (Buabeng-Andoh, 2012b; Chai, 2010; Hsu, 2010; Lau & Sim, 2008; Sorgo et al., 2010; Ting, 2007) and teachers’ attitude toward computers (Jegede et al., 2007). Although teacher ICT competency has been viewed as a prerequisite for ICT acceptance and use in school systems (Archibong et al., 2010), not many empirical studies reported on the relationship between teacher ICT competency and teacher acceptance and use of School Management Systems. Hence, in this study, we expect that teacher ICT competency would influence teacher acceptance and use of SMS. In other words, we would like to examine the relationship between teacher ICT competency and teacher acceptance and use of SMS in Negeri Sembilan secondary schools.

METHODOLOGY

(A) Research Design

This study aimed at examining the relationship between teacher acceptance and use of SMS as the endogenous variable with teacher ICT competency as the exogenous variable. Thus, quantitative research method is applied to explain how one variable affects another (Creswell, 2014) or to establish relationship between variables (Fraenkel, Wallen, & Hyun, 2011). This is a non-experimental quantitative research using survey technique by administrating a set of questionnaires developed for data collection. A cross-sectional and self-administered questionnaire was the data collection tool for this research design.

(B) Population and Sample of the study

The targeted population for this study comprised all public secondary day school teachers in Negeri Sembilan, Malaysia. There are 6499 teachers within 89 schools located at six different districts in Negeri Sembilan. The minimum number of respondents needed for this study at the significance level $p = .05$ is 362 teachers (Krejcie & Morgan, 1970). Sample selection for this study was conducted in several stages by probability sampling procedure involving proportional stratified random sampling, simple random sampling and systematic random sampling. A total of 450 questionnaires were distributed to the respondents and a total of 417 questionnaires collected were analyzed, representing a valid response rate of 92.7%.

(C) Instrument

A questionnaire was developed by the researchers to obtain the information needed for the study. The instrument comprised of respondent demographic variables, teacher ICT competency, and teacher acceptance and use of SMS. Teacher demographic variables are gender, age group, teaching experience,
highest educational level, and experience in using computers.

Teacher ICT competency was measured according to ISTE Standards for Teachers (ISTE Standards•T) as prescribed by ISTE (2008). ISTE Standards•T is a standard for evaluating the skills and knowledge which educators need to teach, work and learn in an increasing connected global and digital society. These standards consist of five dimensions which are: (i) Smart Pedagogy; (ii) Digital age learning experiences and assessments; (iii) Digital age work and learning; (iv) Digital citizenship and responsibility; and (v) Professional growth and leadership. Besides, the researcher also adapted some of the ICT competency standards for Malaysian Science and Mathematics teachers developed by a group of researchers using Delphi technique (Fong et al., 2013).

Teacher acceptance and use of SMS scale was adapted from the Unified Theory of Acceptance and Use of Technology (UTAUT2) Model (Venkatesh, Thong, & Xu, 2012), consisting of six dimensions: (i) Performance Expectancy; (ii) Effort Expectancy; (iii) Social Influence; (iv) Facilitating Condition; (v) Hedonic Motivation; and (vi) Habit.

The developed instrument was pilot tested on 57 secondary school teachers in some secondary schools located in the states of Selangor, Perak and Johor. Data gathered were analyzed using the Statistical Packages for the Social Sciences (SPSS) version 22.0 for internal consistency. The results of analysis showed that the Cronbach alpha for the teacher ICT competency dimensions were between .800 -.929, and teacher acceptance and use of SMS dimensions were in the range of .843–.926. These indicated that the instrument achieved a good level of reliability.

(D) Analysis of Data

Numerical data gathered were analyzed quantitatively using SPSS and Analysis of Moment Structures (AMOS) version 22.0. Both descriptive and inferential statistical methods were used to analyze the data to answer the proposed research questions. Descriptive statistics in terms of mean and standard deviation were used to answer the first two research questions. Inferential statistics, the Pearson product-moment correlation test was performed to examine the relationship between teacher ICT competency and teacher acceptance and use of SMS. Inferential statistics, the multiple regression analysis was carried out to identify which dimensions of teacher ICT competency contribute to the changes in the teacher acceptance and use of SMS. Finally, structural equation modelling (SEM) procedure with AMOS was carried out to evaluate whether the data collected fit with the proposed model of teacher ICT competency and teacher acceptance and use of SMS in Negeri Sembilan secondary schools.

FINDINGS

This section presents the results of the study according to each of the research questions.

The Level of Teacher Acceptance and Use of SMS in Negeri Sembilan Secondary Schools

Descriptive statistics were used to analyze the data collected from 417 teachers in Negeri Sembilan secondary schools. The analysis yielded results as shown in Table 1.
Table 1: Mean, Standard Deviation and the Level of Teacher Acceptance and Use of SMS (N = 417)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Performance Expectancy</td>
<td>7.03</td>
<td>1.49</td>
<td>High</td>
</tr>
<tr>
<td>2) Effort Expectancy</td>
<td>7.00</td>
<td>1.46</td>
<td>High</td>
</tr>
<tr>
<td>3) Social Influence</td>
<td>6.55</td>
<td>1.42</td>
<td>Medium</td>
</tr>
<tr>
<td>4) Facilitating Conditions</td>
<td>7.23</td>
<td>1.34</td>
<td>High</td>
</tr>
<tr>
<td>5) Hedonic Motivation</td>
<td>6.86</td>
<td>1.51</td>
<td>High</td>
</tr>
<tr>
<td>6) Habit</td>
<td>6.45</td>
<td>1.71</td>
<td>Medium</td>
</tr>
<tr>
<td>Overall</td>
<td>6.85</td>
<td>1.32</td>
<td>High</td>
</tr>
</tbody>
</table>

Based on Table 1, the overall mean for teacher acceptance and use of SMS is 6.85. This could be interpreted as high level of teacher acceptance and use of SMS in Negeri Sembilan secondary schools. The results of the analysis for each of the teacher acceptance and use of SMS dimensions indicated that four out of six of the teacher acceptance and use of SMS dimensions showed high level of mean. These dimensions are performance expectancy, effort expectancy, facilitating conditions, and hedonic motivation. The other two of the teacher acceptance and use of SMS dimensions namely social influence and habit demonstrated medium level of mean.

The Level of Teacher ICT Competency in Negeri Sembilan Secondary Schools

The descriptive analysis for level of teacher competency yielded results as shown in Table 2.

Table 2: Mean, Standard Deviation and the Level of Teacher ICT Competency (N=417)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Smart Pedagogy</td>
<td>7.42</td>
<td>1.19</td>
<td>High</td>
</tr>
<tr>
<td>2) Digital Age Learning Experience and Assessments</td>
<td>7.28</td>
<td>1.21</td>
<td>High</td>
</tr>
<tr>
<td>3) Digital Age Work and Learning</td>
<td>7.39</td>
<td>1.14</td>
<td>High</td>
</tr>
<tr>
<td>4) Digital Citizenship and Responsibility</td>
<td>7.19</td>
<td>1.23</td>
<td>High</td>
</tr>
<tr>
<td>5) Professional Growth and Leadership</td>
<td>6.87</td>
<td>1.21</td>
<td>High</td>
</tr>
<tr>
<td>Overall</td>
<td>7.19</td>
<td>1.08</td>
<td>High</td>
</tr>
</tbody>
</table>

As shown in Table 2, the overall mean for teacher ICT competency is 7.19. This could be interpreted as high level of teacher ICT competency in Negeri Sembilan secondary schools. The results of the analysis for each of the teacher ICT competency dimensions indicated that three out of the five teacher ICT competency dimensions have higher mean than the overall mean. These dimensions are Smart Pedagogy, Digital Age Learning Experience and Assessments, and Digital Age Work and Learning. Digital Citizenship and Responsibility dimension has similar mean as the overall mean of teacher ICT competency, while the other dimension, Professional Growth and Leadership showed lower mean than the overall mean of teacher ICT competency. However, all the five teacher ICT competency dimensions have means that are interpreted as high level. These means that the respondents rated themselves as demonstrating high level of competence for all the five teacher ICT competency dimensions in Negeri Sembilan secondary schools.
**Relationship between Teacher ICT Competency and Teacher Acceptance and Use of SMS in Negeri Sembilan secondary schools**

The Pearson product-moment correlation test was performed to examine the relationship between principal technology leadership practices and teacher acceptance and use of SMS. The result of the analysis was presented in the following Table 3.

**Table 3: Pearson Product-Moment Correlation Analysis between Teacher ICT Competency and Teacher Acceptance and Use of SMS**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Teachers’ Acceptance and Use of SMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher ICT Competency</td>
<td>Pearson Correlation: .634**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed): .000</td>
</tr>
<tr>
<td></td>
<td>N: 417</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed)**

Table 3 showed that for the sample of this study (n = 417), there is a statistically significant positive correlation which is moderately strong ($r = .634$, $p < .01$) between teacher ICT competency and teacher acceptance and use of SMS.

**Effects of Teacher ICT Competency on Teacher Acceptance and Use of SMS in Negeri Sembilan Secondary Schools**

The multiple regression analysis yields outputs as shown in Table 4.

**Table 4: Multiple Regression (Stepwise) on Teacher ICT Competency to Teacher Acceptance and Use of SMS (N = 417)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>(Unstad.) B</th>
<th>(Stand.) B</th>
<th>t</th>
<th>Sig</th>
<th>$R^2$</th>
<th>Contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Pedagogy</td>
<td>.368</td>
<td>.330</td>
<td>5.762</td>
<td>.000</td>
<td>.349</td>
<td>34.9</td>
</tr>
<tr>
<td>Professional Growth and Leadership</td>
<td>.248</td>
<td>.226</td>
<td>3.716</td>
<td>.000</td>
<td>.397</td>
<td>4.8</td>
</tr>
<tr>
<td>Digital Citizenship and Responsibility</td>
<td>.159</td>
<td>.148</td>
<td>2.315</td>
<td>.021</td>
<td>.405</td>
<td>0.8</td>
</tr>
<tr>
<td>Constant</td>
<td>1.274</td>
<td>3.781</td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The result of multiple regression analysis shown in Table 4 indicated that the prediction model contained three out of the five predictors. These predictors are smart pedagogy ($\beta = .330$, $p = .000$), professional growth and leadership ($\beta = .226$, $p = .000$), and digital citizenship and responsibility ($\beta = .148$, $p = .021$). Smart pedagogy dimension (model 1) was found to contribute 34.9% of the variance in teacher acceptance and use of SMS ($R^2 = .349$), the combination of smart pedagogy, and professional growth and leadership dimension (model 2) accounted for 39.7% of the variance in teacher acceptance and use of SMS ($R^2 = .397$) while the combination of smart pedagogy, professional growth and leadership, and digital citizenship and responsibility dimension (model 3) accounted for 40.5% of the variance in teacher acceptance and use of SMS ($R^2 = .405$).

The dominant predictor for teacher acceptance and use of SMS is smart pedagogy dimension of the teacher ICT competency ($\beta = .330$, $t = 5.762$ and $p = .000$). The $t$-test result was significant at the significant level of $p < .05$ with the $R^2 = .349$, this indicated that smart pedagogy dimension contributes 34.9% of the variance in teacher acceptance and use of SMS. Based on the standardized beta value, when the smart pedagogy dimension of the teacher ICT competency increased by one unit of standard deviation, teacher acceptance and use of SMS increased by .330 unit of standard deviation.
The second predictor which contributed 4.8% of the variance in teacher acceptance and use of SMS is professional growth and leadership dimension (β = .226, t = 3.716 and p = .000). The t-test result was significant at the significance level p < .05 with the combined R²= .397, this indicated that the professional growth and leadership dimension contributes 4.8% (39.7% - 34.9%) of the variance in teacher acceptance and use of SMS. Based on the standardized beta value, when the professional growth and leadership dimension of the teacher ICT competency increase by one unit of standard deviation, teacher acceptance and use of SMS will increase by .226 unit of standard deviation.

The third predictor which contributed only 0.8% of the variance in teacher acceptance and use of SMS is digital citizenship and responsibility dimension (β=.148, t =2.315 and p =.021). The t-test result was significant at the significance level p < .05 with the combined R²=.405, this indicated that the digital citizenship and responsibility dimension contributes 0.8% (40.5% - 39.7%) of the variance in teacher acceptance and use of SMS. Based on the standardized beta value, when the digital citizenship and responsibility dimension of the teacher ICT competency increase by one unit of standard deviation, teacher acceptance and use of SMS will increase by .148 unit of standard deviation.

Table 5: Multiple Regression Analysis (Stepwise): ANOVA

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>294.726</td>
<td>3</td>
<td>98.242</td>
<td>93.697</td>
</tr>
<tr>
<td>Residual</td>
<td>433.035</td>
<td>413</td>
<td>1.049</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>727.761</td>
<td>416</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on Table 5, the F-test result indicated that there is a significant relationship between the three predictor variables with teacher acceptance and use of SMS [F(3,413) = 93.697, p = .000] at the significance level of p < .05. This multiple regression analysis results also showed that the combination of the three dimensions of teacher ICT competency – smart pedagogy, professional growth and leadership, and digital citizenship and responsibility accounted for 40.5% of the variance in teacher acceptance and use of SMS. This means that as much as 59.5% of the variance in teacher acceptance and use of SMS are unable to be predicted by teacher ICT competency as it may be caused by other variables (other factors) not examined in this study.

Teacher ICT Competency and Teacher Acceptance and Use of SMS Model

The primary task in this model-testing procedure is to determine the goodness-of-fit between the proposed model and the sample data (Byrne, 2010). The analysis yielded results as presented in Figure 2.

Note:
ICT=Teacher ICT Competency;
TAU=Teacher Acceptance and Use of SMS

Figure 2: The Proposed Structural Model.
Figure 2 indicated that the fitness indices of the proposed structural model do not achieve the level of fitness required for RMSEA, GFI, and Ratio Chisq/df. According to Byrne (2010), the re-specification procedure is the model-generating scenario where the researcher, having postulated and rejected a theoretically derived model on the basis of its poor fit to the sample data, proceeds in an exploratory fashion to modify and re-estimate the model. The primary focus, in this instance, is to locate the source of misfit in the model and to determine a model that better describes the sample data. The ultimate objective is to find a model that is both substantively meaningful and statistically well fitting. Thus, based on the suggestion of the modification indices, a few of the measurement errors need to be set as “free parameter” to improve the model fitness. The measurement errors that need to be correlated are e1 with e2, e12 with e14, e14 with e15, and e15 with e16. The re-specified structural model is presented in Figure 3.

![Figure 3. Re-Specified Structural Model](image)

**Note:**
ICT=Teacher ICT Competency

Based on the re-specified structural model shown in Figure 3, it was found that all the fitness indices have achieved the threshold values. This indicated that the re-specified structural model fit with the data collected from Negeri Sembilan secondary schools. The standardized beta value for the ICT→TAU is .64, indicating that when teacher ICT competency (ICT) increases by one standard deviation, teacher acceptance and use of SMS (TAU) would increase by .64 standard deviation. The squared multiple correlation for teacher acceptance and use of SMS (TAU) is .411. This indicated that 41.1% of the variance in teacher acceptance and use of SMS could be predicted by teacher ICT competency. This means that there are as many as 58.9% of the variance in teacher acceptance and use of SMS are unable to be predicted by teacher ICT competency as it may be caused by other variables (other factors) not examined in this study.

**DISCUSSIONS**

School is a complex organization with various functional roles and the information related to its community are overloaded (Kelly & Downey, 2011). Hence, ICT usage has been increasingly incorporated into school management to improve its effectiveness and efficiency (Madiha Shah, 2014; Prokopiadou, 2012). It was commonly acknowledged that the full utilization of SMS could offer invaluable support to schools, which are increasingly being granted autonomy in the school development policy (Bosker, Branderhorst, & Visscher, 2007). However, teachers need to have positive attitudes toward the acceptance and use of school management system (SMS) in order to properly and effectively integrate it into their routine work.

The results of this study indicated that teachers in Negeri Sembilan secondary schools demonstrated very positive attitudes toward SMS acceptance and use. This finding aligned with Albirini (2006), Demirci (2009), Teo (2008), and Pynoo and van Braak (2014) who also found that teachers’ positive attitude towards ICT is the key factor for enhancing teacher acceptance and use of ICT. Besides, this finding is also an excellent indicator of where these teachers have the confidence, desire and readiness to accept...
and use SMS in carrying out their routine work. This was further supported by Madiha Shah (2014) who stated that the main objective of SMS is to implement and design the school’s routine procedures and processes to provide suitable consistent, accurate and timely detailed reports. Thus, we concluded that information technology use in school management has shown some progress. In fact, it could be said that information system usage in school management is increasingly popular among teachers (Madiha Shah, 2014). Furthermore, these teachers found that performance expectancy, effort expectancy, facilitating conditions and hedonic motivation are more important factors regarding their acceptance and use of SMS compared with social influence and habit. This was supported by Wozney, Venkatesh, and Abrami (2006), who found that technology innovations are most likely to be accepted by teachers if the perceived value of the innovation usage and its expectancy of success are high. They revealed that perceived value of innovation usage and expectancy of success were the most crucial in differentiating teachers’ computer acceptance and usage level.

Technology advancement has created a greater demand on teachers to engage with various types of technology in carrying out their routine work (Prokopiadou, 2012; Teo, 2015). Hence, in order to be effective, teachers should not only strive to improve their pedagogical knowledge and instructional skills, but they should constantly adapt to new technologies and refine their knowledge, skills and competencies in order to integrate instructional technology efficiently and effectively (Pynoo et al., 2011). Teacher ICT competency is the driving force toward achieving the goals of technology integration into the classroom (Varol, 2013). Besides, teacher ICT competency can be viewed as a form valuable national asset in terms of human resources which is important in promoting world-class education as outlined in Vision 2020. The results of this study indicated that teachers in Negeri Sembilan secondary schools showed high level of ICT competency for all the five dimensions of teacher ICT competency. This finding was consistent with the findings of Harin Hafian (2011), Tasir, Amin Abour, Abd Halim, and Harun (2012), and Umar and Mohd Yusoff (2014), who also found that Malaysian teachers demonstrated high level of ICT competency. The high level of teacher ICT competency could imply that various training programs implemented by the Malaysian government throughout the years have proved to be beneficial because the majority of the secondary school teachers who have attended them are more computer literate.

The Pearson product-moment correlation test showed that there is statistically significant positive and moderately strong correlation between teacher ICT competency and teacher acceptance and use of SMS. The positive correlation suggests that teachers with higher level of ICT competency will demonstrate higher level of acceptance and use of SMS. Hence, teacher ICT competency is confirmed as one of the factors influencing teacher acceptance and use of SMS. This was supported by the empirical study findings conducted by Buabeng-Andoh (2012a), Chai (2010), Hsu (2010), Jegede et al. (2007), Lau and Sim (2008), Sa’ari et al. (2005b), and Ting (2007), who found a significant relationship between teachers’ ICT competency with their attitudes toward computers, level of computer usage, and more specifically, acceptance and use of ICT. This was further supported by Varol (2013) who stated that teacher ICT competency has been viewed as the critical factor that affects teachers’ decision about their classroom practices.

Furthermore, based on the multiple regression analysis, it was found that smart pedagogy, professional growth and leadership, and digital citizenship and responsibility are the three teacher ICT competency dimensions that are statistically significant predictors of teacher acceptance and use of SMS in Negeri Sembilan secondary schools. This finding implies that the level of teacher acceptance and use of SMS will be increased when teachers are embedded with the use of ICT in their instructional practices, continuously strive to improve their professional practices by promoting and demonstrating effective use of ICT, and are concerned about the social, ethical and legal issues regarding ICT use among their students. This finding was in line with Franklin (2007), Knezek and Christensen (2002) and Varol (2013) who found that teacher ICT competency is the principal determinant to influence teacher effective use of ICT in their classroom practices; Sa’ari et al. (2005b) who found that teachers should be encouraged to create or design more technology-based activities, and share information and strategies dealing with instructional technology among their communities so that they will collectively gain a better understanding of the new digital era technology; and Raob, Al-Oshaibat, and Ong (2012) who stated that teachers must focus on safety, legal, and ethical behaviors as they pertain to instructional technology use. Hence in order to enhance teacher acceptance and use of SMS, there is a need to promote teacher ICT competency according to the dimensions
which have higher impact on teacher acceptance and use of SMS that emerged from the findings of this study.

Data analysis showed that the proposed structural model does not achieve the level of fitness required for some of the fitness indexes. This reflected that the proposed structural model does not fit well with the data collected from Negeri Sembilan secondary school teachers. Hence, a re-specified structural model, as shown in Figure 3 has been established.

CONCLUSION

Technology has played an important role in schools around the world. Teachers and administrators are using technology in some aspect of their daily activities. According to Dede (2010), the twenty-first century seems to be very different if compared with the twentieth century in terms of skills and competencies people need to carry out their work and for their citizenship and self-actualization. In response to these, each society’s educational system has to transform pedagogical objectives and curricula and assessment delivery for their students to help them to attain the excellent outcomes for a successful lifestyle reflected upon their effective contribution in the workplace and citizenship. Hence, the move to technology use is very much needed in order to engage this techno-savvy generation in their instructional process (Lewis, Fretwell, Ryan, & Parham, 2013).

In Malaysia, all public secondary schools are required to use School Management System (SMS) mandatory starting from 1st January 2015. Based on The Interim Strategic Plan 2011-2020 (Ministry of Education Malaysia, 2012b), this educational management system in the “Policy on ICT in Education” (Ministry of Education Malaysia, 2010) is the prerequisite for Malaysia to become a developed nation. The positive correlation between teacher ICT competency with teacher acceptance and use of SMS revealed that regular professional development to improve teacher ICT competency would help to enhance the level of acceptance and use of SMS. Hence, in order to enhance teacher acceptance and use of SMS, teachers need to acquire higher level of ICT competency for the betterment of school management by using SMS in Malaysian secondary schools. Besides, policy makers should design professional development programs to inculcate in teachers more effective and efficient ways to employ technology for learning as mentioned in shift seven of the Malaysia Education Blueprint (Ministry of Education Malaysia, 2012a).

REFERENCES


The Geometric Construction Abilities Of Gifted Students In Solving Real - World Problems: A Case From Turkey

Avni YILDIZ[1]

ABSTRACT

Geometric constructions have already been of interest to mathematicians. However, studies on geometric construction are not adequate in the relevant literature. Moreover, these studies generally focus on how secondary school gifted students solve non-routine mathematical problems. The present study aims to examine the geometric construction abilities of ninth-grade (15 years old) gifted students in solving real-world geometry problems; thus a case study was conducted. Six gifted students participated in the study. The data consisted of voice records, solutions, and models made by the students on the GeoGebra screen. Results indicate that gifted students use their previous knowledge effectively during the process of geometric construction. They modeled the situations available in the problems through using mathematical concepts and the software in coordination. Therefore, it is evident that gifted students think more creatively while solving problems using GeoGebra.

Keywords: Gifted students, Geometric construction ability, Real-world problems, Problem solving, GeoGebra software

INTRODUCTION

NCTM (2000) emphasizes that geometric construction refers to meaningful learning. Geometric construction helps students realize the relations among different geometric models and develops their problem solving abilities (Napitupulu, 2001; Posamentier, 2000). Mathematics teaching and problem solving should be considered together in contemporary education. It is significant to determine students’ problem solving abilities as well as developing them. It becomes much more significant that gifted students are considered as different from ordinary students.

Educators define the concept of giftedness in various ways as gifted students have different abilities. According to the studies carried out in mathematics education, gifted students are successful in problem solving processes such as organizing materials, using templates and rules, modifying the problem statement, using new expressions in templates and rules, understanding and studying on complex issues, reversing the processes and finding relevant problems (Gross, 2004; Lupkowski-Shoplik, Benbow, Assouline & Brody, 2003; Miller, 1990; VanTassel-Baska, 2000). Gifted students are characterized by their abilities to pay continuous attention to problem solving and their tendency to question, to test, and to explore (Johnsen, 2004). Their problem solving skills are much better than those of non-gifted students (Knepper, Obrzut, & Copeland, 1983). Gifted students tend to be more successful in solving mathematical problems than their non-gifted peers (Gallagher, 1975; Renzulli, 1978). Furthermore, gifted students use mathematical skills as effectively as older students do (Sowell, Zeigler, Bergwell, & Cartwright, 1990).

It is important to state gifted students’ learning process efficiently. The study by Yıldız, Baltacı, Kurak, and Güven (2012) found that gifted students make decisions in a more different and faster way than the
other students. They proceed fast, not step-by-step, skipping conceptually; furthermore, they find complicated connections among the parts by seeing the subject as a whole (Holton & Gaffney, 1994; Heward & Orlansky, 1980). Thus, gifted students should be given different sources of activities rather than given the unnecessary repetitions like other students (Meyen & Skrtic, 1988). In this manner, Kirk and Gallegher (1989) expressed that the learning process of gifted students should be faster than the other students’, and they should be presented various kinds of materials.

Students need to utilize their intuitive knowledge and experiences in order to solve real-world problems (Nesher & Hershkovits, 1997). Hence, real-world problems are required to be incorporated into mathematics teaching. Due to rapidly changing conditions around the world, a great number of problems and events affect our personal and professional lives to a large extent. The main skill we should have under these conditions is not to treat these problems superficially (Broudy, 1982). In other words, people who are able to “solve problems” should be trained through a qualified education program. A number of educationalists state that problem solving is highly significant in achieving educational success and it, therefore, should be the main objective of mathematics teaching at all levels of education (Charles & Lester, 1984). Dynamic software is considered as an auxiliary element in this process. One of the dynamic geometry software, GeoGebra is a tool for encouraging and motivating teachers for incorporating geometric constructions (Stupel & Ben-Chaim, 2013).

GeoGebra is free, open source-coded, with multiple representations (e.g., different windows for algebraic and geometrical input) and it offers individualized language options, interactive commentary and Internet options for sharing sources (Hohenwarter, Hohenwarter, Kreis, & Lavicza, 2008). GeoGebra transfers mathematical symbols, graphics, and values via various windows (Aktümen, Horzum, Yildiz, & Ceylan, 2010). Through algebra and graphics windows, it enables views of algebraic and graphical changes on the chart at the same time (Hohenwarter & Jones, 2007). Moreover, it contributes to the modeling of real life problems (Baltaci, 2014; Price & Stacey, 2005). It is a versatile tool for visualizing and objectifying mathematical concepts (Hohenwarter & Jones, 2007; Hohenwarter, Preiner, & Yi, 2007). Also, GeoGebra software expands the dynamic geometry concepts, and adds a new dimension to mathematics and algebra (Dikovich, 2009). Furthermore, some innovations have been introduced with the new versions of GeoGebra (i.e., GeoGebra 3D window). Within this context, it is getting easier to visualize 3D subjects owing to this window (Yildiz, Baltaci & Aktümen, 2012). Having all these functions, GeoGebra is a useful tool in teaching and learning geometry.

Studies on how gifted students solve problems are usually based upon how secondary-school gifted students solve non-routine mathematical problems (Duzakin, 2004; Garofalo, 1993; Sriraman, 2003). Besides, learning geometry involves three cognitive processes: visualization, geometric constructions and reasoning. While various studies are available regarding visualization and reasoning (Baki, Kosa & Guven, 2011; Gutierrez, 1992; Guven & Kosa, 2008; Wong & Bukalov, 2013; Yolcu & Kurtulus, 2010), only a few studies focus on geometric construction. Considering the studies conducted on geometric constructions in the literature, a few studies such as teachers’ usage of geometric construction process in lessons (Erduran & Yesildere, 2010), the relationship between the construction activities and students’ Van Hiele geometric thinking level (Cheung, 2011; Guven, 2006) and the usage of different construction tools (compass, ruler, dynamic geometry software etc.) in geometric construction activities were examined (Kondratieva, 2013; Kuzle, 2013; Pandiscio, 2002). In Turkey geometric construction activities are available in mathematics and geometry teaching programs starting from primary school to high school; however, several problems arise in the process of these activities (Erduran & Yesildere, 2010). Geometric construction levels of gifted students are not taken into consideration in solving real-world problems in Turkey. Therefore, the current study aims to examine the geometric construction abilities of ninth-grade (15 years old) gifted students in solving real-world geometry problems. In parallel with this, the research questions are;

1. How are geometric construction abilities of ninth-grade gifted students in solving real-world geometry problems with pen and paper?

2. How are geometric construction abilities of ninth-grade gifted students in solving real-world geometry problems with GeoGebra dynamic mathematics software?
METHODOLOGY

In this section, the research method, participants of the study, application process, data collection and analysis are presented.

Research Method

In the present study, a case study method was used to investigate a certain group deeply and to assess the data without any concern about generalization. According to Yin (2003) a case study design should be considered when: (a) the focus of the study is to answer “how” and “why” questions; (b) it is impossible to manipulate the behavior of those involved in the study.

Participants

Gifted students in Turkey receive education in the Science and Arts Centers which are different educational institutions independent from formal school programs. The selection of gifted students for these education centers is composed of six stages, namely: diagnosis, designation for candidacy, preliminary evaluation, group scanning, individual scrutiny and enrolment-placement. Students who succeed in all stages have the right to receive education in those Science and Arts Centers, which means that Turkey is hypercritical concerning selection of gifted students.

The participants were determined through purposeful sampling approach in the present study. Purposeful sampling method is used to identify and select information rich cases (Patton, 2005). While deciding on the participants in the research, the researcher took into consideration the skills of self-expression and ability to volunteer for clinical interview. The study involved six ninth grade gifted students, three males and three female. Five of them have been in the Science and Art Centers since the fourth grade (10 years old), and the last one has been in the Science and Art Centers since the fifth grade (11 years old). In addition, all of the participants were successful students and their grades were all 5 out of 5. All the students also have the skills required to use GeoGebra dynamic software.

Application Process

Before the application process, the gifted students were taught how to use GeoGebra software in 9 days, during holidays, in the Science and Arts Center. During this process, the GeoGebra interface was presented to students and they were informed about how to use GeoGebra software; then they performed a variety of activities. A pilot study was done with two gifted students with the aim of determining the expected problems. Following the pilot study, the problems prepared by the researcher and the questions asked during the clinical interview were checked by two field experts for application after the general revision. The problems are presented in the Appendix.

Students were informed about the purpose of the study superficially before conducting the application. During the application, the problem solving process of each student was examined in detail with a clinical interview. Each of the interviews occupied approximately one hour; all of them were performed in the counseling room, which was quiet enough to relax the participants.

Data Collection

The data included voice records, students’ solutions and models on the GeoGebra screen. Before conducting the research, the questions asked in the clinical interview were told to the students. The problems were prepared in accordance with the mathematics curriculum and students’ textbooks; besides, three problems were chosen out of these problems by asking the views of mathematics teachers working at the Science and Art Center and two field experts.

Data Analysis

Three problems were asked to the gifted students. During this activity, students were interviewed and their answers were recorded. Following that, the data were presented to the participants in order to avoid misunderstandings.
Before the data analysis, the interviews and the solutions of problems were transcribed verbatim and checked. The related information was given to a field expert. Then, the themes were separately developed by the researcher and a field expert. All the analyses were finalized by bringing together and discussing them. At the end of discussions, the agreed themes were propounded so as to constitute an answer to the research problem. This is a significant requirement referenced in ensuring the validity of the research. Furthermore, Wolcott (1990) stated that explaining the results with direct quotations of the real individuals is important for reliability of the study. Thus, it is tried to create the reliability by giving some of the data directly from the current study.

FINDINGS

The findings were composed of direct quotations, students’ solutions, and models on the GeoGebra screen.

First Problem Solving Process

Four of the gifted students answered the problem correctly in writing. As an example, G1’s expressions are as follows:

R: How do you think to solve the problem?
G1: We found the height is 80 cm. The site of the angle is four divided by five.
R: Yes.
G1: The cover’s height is 60 cm. Because this length is 10 cm and that one is 10 cm too (being parallel to edges and 10 cm apart from these edges). I found 60 if 80 minus 20.
R: You said the height of the cover is 60 cm.
G1: Yes. The edges are in parallel to each other. Therefore, the angles and the sine are equal.
R: How?
G1: They are corresponding... 60 divided x equals 80 divided by 100. So x is 75 cm.
(G1: Gifted student 1, R: Researcher)

FIG. 1. G1’s solution in paper and pencil environment.

All students were successful in modeling with an appropriate rate. And, some of the gifted students’ ways of thinking, while modeling rhombus via using special triangle, were different. G4’s expressions are presented as an example below:
R: How can you model this problem on the software?
G4: I’ll model it with an appropriate rate as it is real world size.
R: How?
G4: Instead of 100 cm, it can be 10 cm. It will be 8 cm for the height, then.
R: Let’s do it.
G4: I won’t model the rhombus in these rates. I can do something else.
R: So how?
G4: The height is 8 and one of the edge is 10. Then we can use 6-8-10 special triangle.
R: Do it please.
G4: I modeled it by using parallelism. This is our cover.

Different from the others, G2 and G3 constructed the problem as following and accomplished.

G2: The starting point of the line segment is (6,4). In order to be 10 unit away, lets mark (16,4).
R: Yes.
G2: The height is 8, so I marked (16, 12). We can find the table by compounding these points and line segments...

G6 made several mistakes during the modeling, but it was observed that they corrected the mistakes immediately subject to the feedback. G6’s model is presented in Figure 2.

G6: There is a length button between the two points. If I am not mistaken, I will find out one of the edge’s length of the cover.
R: OK. Let’s find it.
G6: 12.51.
R: So, you say one of the edge’s length of the cover is 12.51.
G6: Yes. I want to find out whether the other lengths are the same or not.
R: Let’s see.
G6: I think it is enough to find out one edge more. But the length is 12.4 in here.
R: Where is the error?
G6: I made a mistake while scrolling through. I haven’t taken it as parallel.

Then, the students modeled the line which is short of 10 cm and parallel to the edges with the intersection of perpendicular lines and circles correctly. This process was exemplified by G5’s expressions as...
follows:

G5: Parallel to this, it is 1 unit away. How can I measure it? Maybe from the circle.

R: How?

G5: We cannot draw perpendicular line to line segment in the program. For this reason, I will use the circle. I am drawing 1 unit radius circle on one of the points of rhombus. After that, I am drawing a parallel line through the center of the circle like that. After doing the same thing for the other edges, I will form the cover by taking the intersections of the lines.

The situation witnessed above gives clues regarding gifted students’ geometric construction abilities since modeling of intended situation available in the problem is determined only when some mathematical concepts and the software are used coordinately. Then, all the students solved the problem correctly. To illustrate, G1’s model for the first problem is presented in Figure 3.

Next, all students checked the correctness of the final result by means of graph and algebra windows of the software.

**Second Problem Solving Process**

It was determined that gifted students visualized the models when the problem was understood. It indicates the ability of gifted students while doing the mathematical processes in their minds correctly and practically. G3’s expressions are presented as an example:

R: Can you make a prediction about the result of the problem?

G3: The height is 30 cm. Radius is 20. If we take 3 for the π, the answer is 1200x30=36000 cm²

R: Why do you think so?

G3: Did I make a mistake? I think not.

As pointed out above, all of the students solved the second problem correctly in their minds. Still, how the geometric construction occurred through Geogebra software is a question of debate expected to be answered. Hence, students were asked to model via using the software. It was observed that all the students reduced the figure at the appropriate rate. For instance, the models of G2 (Figure 4), G4’s (Figure 5), and G5’s expressions during the process of geometric construction are presented below:

G5: I take 4 unit cube to modeling in the software.

R: OK.

G5: I will draw a circle for the cylinder.

R: Where?

G5: On the base of the cube.

R: How can you draw?
G5: Firstly, I form a line segment like that. The middle point would be like that via the software.

R: Then, what are you going to do?

G5: (thinking) To form the radius, I will draw perpendicular from the center to the edge of the cube. This would be like that via perpendicular line toolbar of the software. Then, for the radius, I state the line segment and hide the line.

As can be observed in the figures above, it was not easy to construct the biggest cylinder into the cube. During the construction process, the gifted students had to use their prior mathematical knowledge so as to understand the toolbar presented by the GeoGebra software, and so they accomplished. Furthermore, students were encouraged to use the 3D window easily even though GeoGebra dynamic software had been already presented to them, which ensures that gifted students have high capacity for learning. Moreover, it was confirmed that the students made observations through rotating and coloring the models for a long time. It clarifies that practical and functional use of 3D window of the GeoGebra software had an effective role in this situation.

Third Problem Solving Process

It was identified that all of the students could not make reasonable predictions related to the result of the third problem. The expressions of G3 and G6 for this situation are given below:

R: Can you make prediction about the result of this problem?
G3: Let me find out the average result of the problem.
R: How?
G3: At first, I will find the quarter of it. So I divide it 4.
R: What is divided by 4?
G3: The big one, it is 75, and if this part is 50, then it becomes 125.
R: Can you make prediction about the result?
G6: What is π?
R: 3.
G6: It is about 190.
R: Why?
G6: The addition of areas of the half circle whose radius is 10 and the quarter circle whose radius is 7, is about 190.

It was observed that the students did the operations successfully and fast in their minds while making predictions as above; nevertheless, the problem is that the students failed in terms of the inappropriate planning related to the solution of the problem. In any case, G2, G5 and G6 modeled and solved the third problem incorrectly in writing. However, G2, G5 and G6 modeled this problem correctly by specifying the previous mistakes in the software. Accordingly, it refers to the fact that these students interpreted and evaluated the mathematical operations and the results from the graphic and algebra screens of GeoGebra successfully. The model and evaluation of G2’s expression (Figure 6) are presented below:

FIG. 6. G2’s incorrect model on paper.
G2: Ohh. I realize it. I made a mistake. It does not surround this part.

R: Why?

G2: Because the rope comes here but not there. I made a mistake here.

R: What kind of mistake?

G2: Because the sheep goes around 7 m. It can come here at most, and then it can go 3 m away, so it cannot come here.

Then, they completed the geometric constructions using the software as in G5’s case:

G5: Now, I will form the rectangle. I am drawing 6 unit line segment with the software toolbar. But this toolbar draws the line segment on the right side. How can I draw rectangle?

R: Think a bit.

G5: Maybe, firstly, I will draw a vertical line at the end of the line segment to the same line segment. Then, to state the 4 unit distance, I will use the center and radius length and circle menu. I will take the intersection of the line and circle’s end point. Then, I will hide the line which is in the same direction with this line. The rest is easy.

All the gifted students created the rectangles as in G5’s construction process above. During this process, students used the features of line segment, vertical line, circle and parallel line. In this way, students succeeded in constructing the rectangle through using mathematical information coordinately. Then, all students found the result by drawing circles where the sheep could walk around.

DISCUSSION

It was determined that the gifted students were able to solve all the problems by means of connecting the rich features of the GeoGebra software with the personal abilities with an elaborative analyzing process. In parallel with this finding, Baki, Yıldız and Baltacı (2012) demonstrated that the gifted students solve real-world problems easily with different ways of thinking provided that they are given efficient opportunities. Additionally, Rogers (2002) stated that there should be special classrooms for gifted students, and in this way, there could be a competitive environment as well as opportunity for sharing knowledge with their peers. As indicated by Anabousy, Daher, Baya’a and Abu-Naja (2014), González and Herbst (2009), and Santos-Trigo and Cristóbal-Escalante (2008), the gifted students discover by experiencing through the GeoGebra software. Contrary to some other software, diversity of GeoGebra software plays a significant role in the study as GeoGebra is free and integrates algebra and analysis in a single package (Tatar, Akkaya, & Kagızmanlı, 2014).

Hence, in the current study, all the gifted students constantly questioned and checked the models. Consequently, as discussed in Ellerton’s (1986) study, the gifted students are quicker at realizing their errors during problem solving. All the gifted students were successful in modeling the figures by reducing them with an appropriate rate in the software. Besides, as Wieczerkowski, Cropley, and Prado (2000) stated, solving the problems expeditiously or memorizing the symbols, numbers, and formulas are not accepted as indications of being gifted. Similarly, Wang (1989) and Ellerton (1986) concluded that gifted students were good at effective planning. In conclusion, the gifted students participating in this study succeeded in their thinking processes while trying to solve real-world problems. Shore and Dover (1987) expressed that the thinking process of the gifted students is different, because they need more thinking abilities in order to evaluate what they learn (Amick, 1985). Thus, the gifted students think analytical, inductively and deductively in solving hard and complicated problems (Holton & Gaffney, 1994).

It was found that students made observations for a long time after they set models via GeoGebra software. It is likely that the practical and functional use of the 3D screen of the GeoGebra software had an effective role in this situation. Under the strength of this finding, it is claimed that the gifted students were willing to work systematically. This situation is not in parallel with the study of Heinze (2005) who found that these children stood out in their high ability to verbalize and to explain their solutions. However, Gorodetsky
and Klavir (2003) stated that the gifted students demonstrated reflection in action during problem solving.

Students could not decide where to commence a construction activity at first (Erduran & Yesildere, 2010). However, all of the students managed to overcome this problem by effectively using their mathematical abilities in the construction process. While solving the first problem, some of the gifted students’ way of thinking in modeling rhombus by means of using special triangle was different from the others. Likewise, Sisk (1987) and Scruggs and Mastropieri (1985) stated that the gifted students can find different solutions and make creative interpretations. Besides, the gifted students were able to use the information, learned in the geometric construction process, when required, successfully since the modeling of intended situations in the problems occurred only through using some mathematical concepts and the software coordinately. This finding is compatible with the findings of Laborde, Kynigos, Hollebrands and Strasser (2006); in that learning is not quite easy in the environments where dynamic geometry construction is used as the students reconstituted their own geometry knowledge. In addition, Baltaci and Yildiz (2015) and Sendova and Grekovska (2005) pointed out that building a computer model of a construct is motivated to elaborate one’s knowledge in mathematics.

All in all, it was verified that gifted students think more creatively during geometric constructions thanks to the functionality and practicability of the GeoGebra software. As Mainali and Key (2012) point out, students start to explore concepts as a result of using the dynamic software. Thus, dynamic software is expected to have a significant place in the education of gifted students. It is essential for countries to improve the abilities of gifted students. As discussed previously, in Turkey, the construction activities are carried out solely via compass, ruler and quadrant, in order to draw models and let them see what they did during the construction process, in primary and secondary school education. Nevertheless, geometric construction works are of value not only for developing the skills of using drawing tools, but also for developing the students’ ability of thinking deeply with regard to their construction processes (Cherowitzo, 2006). Cheung (2011) found that the experience of geometric construction inspires students more for thinking deeply. Thus, the teachers, trying to give fruitful lessons, should use GeoGebra dynamic mathematical software actively in order to develop their students’ thinking abilities.

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Appendix-1. The Problems Used in This Study

First Problem: Tuğba’s mother wants to sew a cover for the rhombus kitchen table. One of the edges is 100 cm and the area is 80 dm². The cover needs to be parallel to the edges of the table and 10 cm remote from each edge. But she cannot find the appropriate size of this cover. Can you help her to find the size of the cover?

Second Problem: Mehmet finds a cube block whose one edge is 40 cm. He wants to cut this cube from the point which is remote 10 cm from the upper base as parallel to the lower base. He also, wants to form a cylinder from the bigger piece of two. What is the volume of the cylinder block?

Third Problem: While Akif was going to his village, he met his uncle. He saw that his uncle bound a sheep to the cottage, and he was curious about how far the sheep could graze in this area. To find an answer for this question, he decided that the size of the cottage was 4 and 6 meters, the sheep could not jump from the cottage and the sheep was bound with a 10 m rope from the midpoint of the longest edge of cottage. How does Akif find the grazing area of the sheep?
ABSTRACT

The transformation of technology in the 21st century has produced children who are technology savvy and exposed to the internet and social networking at a very young age. These children are already in our school system. Thus teachers too need to use technology and transform the learning environment to meet the requirements of these children. This article discusses the need for transforming the primary school science teaching environment so that school children could have meaningful learning using tools familiar to them. However, while some parts of Malaysia are developing very rapidly, others are not developing as rapidly. School children in some areas are just as contented to share a single desktop computer without the Internet for a lesson. Thus teachers need to be creative to transform and improvise the learning environment to meet the pupils’ needs. This article discusses a case study on seven excellent teachers of primary school science from different parts of Malaysia. The findings of the study indicated that the excellent teachers have improvised their teachings and teaching environment to meet the needs of their pupils and the curriculum for 21st century learning.

Keywords: 21st century pupils; science teaching for primary school; pupils’ needs; teaching and learning tools; teaching and learning environment

INTRODUCTION

Learning as we know traditionally is a process that usually happens in a classroom where the pupils sit in rows at desks and teachers lecture in front of them. Thus a learning environment is usually perceived as a place and space where teaching and learning happens in places such as schools, classrooms or a library. However, today’s learning environments need to embrace the variety of places, ideas, and people that the modern world demands. These reflect a flexibility of space, time, people, and technology (Machado, 2013).

In contrast to traditional learning, 21st century learning needs students to acquire skills that allow them to be involved in their own learning (Prensky, 2008). Although most 21st century learning takes place in physical locations such as schools, in today’s globalized and technology-driven world, a learning environment can be virtual, online, remote; which in other words, it need not be conducted in a place at all. Thus a 21st century learning environment could be generalized as a system that organizes the conditions in which humans learn best. This system must accommodate the unique learning needs of every learner and support the positive human relationships needed for effective learning. These learning environments should be able to support and inspire students and educators to acquire the knowledge and skills needed in the 21st century.

The Malaysian government has a vision for Malaysia to be a developed country by 2020. This implies that the country needs a workforce equipped with skills enabling them to compete and be marketable globally. To achieve this, teaching for the 21st century needs to prepare pupils for a complex life and work environment in the 21st century (NEA, 2013; Partnership for 21st Century Skills, 2007). Learning and innovation skills relevant in preparing pupils for the 21st century skills are:
Critical Thinking and Problem Solving (e.g., effectively analyze and evaluate evidence, arguments, claims and beliefs; solve different kinds of non-familiar problems in both conventional and innovative ways).

Communication (e.g., articulate thoughts and ideas effectively using oral and written communication skills in a variety of forms and contexts).

Collaboration (e.g., demonstrate ability to work effectively and respectfully with diverse teams).

Creativity and Innovation (e.g., use a wide range of idea creation techniques to create new and worthwhile ideas).

This means that if our students are to compete globally today, they must be proficient critical thinkers, communicators, collaborators and creators. The traditional need to equip pupils with the 3R skills (reading, writing and arithmetic) is no longer adequate (NEA, 2013). Primary and secondary school teachers should be competent and able to teach effectively to promote these skills. These teachers need to change the way they teach as the 21st century pupils now come to school with very different sets of experiences and expectations than the 20th century pupils. These technology savvy people navigate their life far differently than many of their teachers. Thus to be able to connect, relate and motivate them, teachers need to be open to new ways of teaching that support the pupil’s needs (Apple, 2008; Lemke, 2010; Rotherham & Willigham, 2009).

In adapting to these new ways of teaching, teachers may be surprised that their pupils have already acquired the skills needed for the 21st century learning from outside the classroom. These pupils live their lives digitally every day, in the form of Internet, text messaging, social networking, and multimedia in their lives outside the school so they expect their learning process to be interactive and engaging with application of technology. A disconnection between the way they live and the way they are taught when teachers continue to teach with 20th century teaching style will lead to demotivation and boredom in the classroom.

There is not much difference between the approach to teach the 21st century learners from the previous ones. We still want our pupils to be creative thinkers and problem solvers who have the necessary skills to function effectively in society and their workplace. The differences lie in how the skills are incorporated in the classroom and how technology is integrated into their teachings. To be able to do so will certainly change the way a teacher instructs (Beers, 2013). Beers suggested instruction that meets the needs of today’s pupils incorporate:

- a variety of learning opportunities and activities
- the use of appropriate technology tools to accomplish learning goals
- project and problem based learning
- cross-curricular connections
- a focus on inquiry and student-led investigations
- collaborative learning environments, both within and beyond classroom
- high levels of visualization and the use of visuals to increase understanding
- frequent formative assessments including the use of self-assessment

Teachers could not claim that they have successfully taught for the 21st learners by simply using the tools needed. To teach successfully with the 21st century tools, teachers should be able to integrate the tools with various teaching strategies and approaches (Lieberman & Mace, 2010; Yost, Senter & Bailey, 2000). Using PowerPoint to deliver a lesson today is no longer adequate, but instead it has become out of date and a source of boredom when pupils have to sit and listen to the teacher talking and referring to the slides from the beginning to the end of a lesson. This approach is similar to using a whiteboard and transparencies which is teacher centered and does not allow the pupils to explore what they have learnt. IT-based teaching tools such as computers, projectors, interactive whiteboards and even simply a whiteboard could be utilized successfully if teachers are able to think creatively and involve pupils in the teaching and learning process. As mentioned by Beers (2013), they should provide lots of opportunities for learning,
project and problem based and let pupils inquire by doing investigations. Thus the 21st century teaching environment need not imprison the student in a classroom from the beginning to the end of the lesson, but instead transform it into an environment where students are free to move about, search for answers to the problems posed by the teacher and communicate freely with their peers.

The 21st century teacher should never restrict lessons to only a given space and time. For example, a teacher who has always taught a certain period a week will normally conduct the classes in the classroom, labs or computer labs. The teaching and learning process occurs in the given time and space where, for most pupils, once they leave the classroom, that will be the end of the topic. The only other time pupils will look back into the topic is when they need to revise it for exams. On the other hand, teachers adopting 21st century teaching will be able to attain the pupils’ attention, keeping them focused on the topic by giving them tasks, to explore and search the internet, discuss with friends via emails, social networking or smart phones. Most of these networking sites are free, social in nature and promote self-expression, allowing multiple users to participate by editing, commenting and polishing a document collaboratively, rather than working alone (Apple, 2008; Lemke, 2010). This will keep the pupils focused on the topic, and the lesson continues even though pupils have already left the school. The teacher could simply monitor the pupils’ work or facilitate them by keeping in touch with them through social networking, smartphones and so forth.

Teaching science should not limit teachers and pupils to classrooms or laboratories. A class could be conducted as successfully at the school field, garden, assembly area or even at the cafeteria depending on the topic being taught. The main idea is to engage pupils in their learning by giving them space to do so. It is such as waste that when abundant resources are outside the classroom for pupils to explore, they are made to listen to teachers and see pictures only from the textbooks. Pupils in the 21st century, also known as the digital natives live their lives digitally everyday (Pearlman, 2010; Tapscott, 1998). They use the Internet, text messaging, social networking and multimedia fluidly in their lives outside the school. Thus, providing them with parallel level of technology opportunity in their academic life could lead to interest, engagement and learning. It is the disconnection between the way the pupils live and the way they learn that is causing loss of interest and their engagement ultimately suffers (Blackmore, 2008)

Technology in science teaching and learning supports the teaching and learning process. Teachers still play the important role of conveying knowledge and facilitating the learning process. However, the 21st century learners need to think and solve problems, communicate, collaborate, create and innovate to prepare them for the 21st century workforce. Thus, peers play an important role in facilitating the learning process, as the pupils sit together and agree on ways to solve problems, and then select the most appropriate approach to do so. In the problem solving process, technology plays an important role for pupils to search, gain ideas, collect information, present ideas and communicate among themselves.

In Malaysia, information technology could easily be accessed by most schools and households. The Internet has become a crucial part of the people’s lives and computer labs are available in most schools. Most urban pupils are computer literate and could at least use the Internet to communicate. In promoting learning for the 21st century skills, the new science curriculum, Kurikulum Standard Sekolah Rendah (Standard Curriculum for Primary School) called Dunia Sains dan Teknologi (The World of Science and Technology) trained pupils as early as in Year 1 to use the computer to search for information, use email or present their work (KPM, 2011). Most pupils in the urban areas are used to computers and gadgets. On the other hand, those in the remote areas are not as technology savvy as their urban counterparts and were introduced to computers and technological tools through formal education at school. These pupils are not as proficient in using computers.

Because of these differences, teachers need to be able choose and adapt their lessons so that no pupils are left behind in 21st century learning. The main aim is to promote thinking and solve problems through various strategies and approaches that allow pupil to communicate and collaborate to solve them. Teachers need to be creative and able to adopt and adapt strategies for maximum outcomes. This article discusses a case study on seven excellent teachers in different parts of Malaysia. Since most parts of the country have already had access to information technology, the study sought to reveal if teachers teach to meet the needs of the 21st century learners. The objective of the study was to observe primary school excellent science teachers’ style of teaching and investigate whether the teachers are able to conduct lessons to promote
thinking skills and problem solving using the 21st century environments.

The Study

Most excellent teachers are awarded with the title as they were able to teach effectively and innovatively. Most are involved in various academic activities and contributed to the education system as module writers, presenters and teacher coaches. This study hoped to find out how selected science excellent teachers perform in the classroom, the approaches they used to teach different topics in science, the teaching and learning environment chosen for the lesson, and their utilization of technology or teaching tools for 21st century learning. A total of seven science teachers who have won excellent teacher (ET) awards were chosen from a list of excellent teachers in primary schools in Malaysia. The teachers were chosen conveniently from a list of excellent science teachers from Selangor, Putrajaya, Perak, Kedah, Terengganu, Sabah and Sarawak so as to cover all parts of Malaysia. The teachers were given pseudo names ETS (Selangor), ETPj (Putrajaya), ETP (Perak), ETK (Kedah), ETT (Terengganu), ETS (Sabah) and ETSw (Sarawak) based on their home state. These teachers are degree holders and have teaching experience of two to eight years.

This was a qualitative study where the main data collection method involved classroom observations, interviews, and analysis of pupils’ work and administrative documents. Thus findings of the study cannot be generalized to the science ET population in Malaysia. During classroom observations, the researcher made records by video recording the lesson and taking field notes. The video recordings were then transcribed for analysis. Interviews were then conducted on the excellent teachers, their pupils, school administrators and peers. The observations and interviews were transcribed and coded and then categorized into themes for discussion (Table 1).

FINDINGS AND DISCUSSIONS

To be able to teach effectively for the 21st century, teachers need to be receptive of the changes rapidly occurring around them. As pupils nowadays are mostly born into the digital era, the curriculum has also changed to be able to equip them with the 21st century skills. Pupils as young as in the primary school must be equipped with the appropriate thinking and problem solving skills, communication and collaborative skills and think creatively and innovate. Although teaching should now be pupil centered, a teacher still plays the main role to teach and facilitate the pupils and keep them focused on the subject matter. The analysis of the study on the seven excellent teachers shows the teaching and learning trends among the excellent teachers’ classes (Table 1).

Table 1 Teaching and Learning of an Effective Teacher

<table>
<thead>
<tr>
<th>Teaching activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set induction</td>
</tr>
<tr>
<td>promotes thinking, singing, question and answer, revision of previous lessons, relate to the things around them</td>
</tr>
<tr>
<td>Strategies</td>
</tr>
<tr>
<td>constructivist, inquiry, contextual, mastery</td>
</tr>
<tr>
<td>Assessment</td>
</tr>
<tr>
<td>formative assessment; question and answer, activity books</td>
</tr>
<tr>
<td>Motivation</td>
</tr>
<tr>
<td>interesting activities, pupils visualize, positive reinforcement, facilitate pupil with tasks</td>
</tr>
<tr>
<td>Communication</td>
</tr>
<tr>
<td>simple and brief explanation, pupils work in mixed ability groups, use simple sentences that pupils understand, keep pupils focused on the tasks given</td>
</tr>
<tr>
<td>Resources</td>
</tr>
<tr>
<td>ICT, things available in the classroom, places around the school, any easily available items</td>
</tr>
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</table>

The seven excellent teachers interviewed agreed that set induction is a crucial part of the lesson as it keeps the pupils focused on the topic and content taught. One teacher responded that ‘Set induction is important part of a lesson as it prepares pupils to be focused on the topic that a teacher intends to teach. It make them interested in learning’(ETS). The teacher believed that set induction triggers pupils to think about
an issue and motivates them to learn. An observation of ETPj showed the teacher using multiple approaches to begin his lesson on teeth. He initially played a song *Chan Mali Chan* with the lyrics changed according to the topic and sang along with the pupils. The pupils sang loudly and were still robust even though the school session was almost over. The teacher later instructed the pupils to open their mouths and count each other’s teeth before starting his lesson.

The analysis of class observation and interviews shows that excellent teacher strategized well for a lesson for optimum learning. For most lessons, excellent teachers adopted constructivism, inquiry, contextual and mastery learning. Teachers were observed to have used things that pupils are familiar with for the lessons and encouraged communication among the pupils. ETPj responded, ‘To me personally, for each T&L sessions I will try to make sure that the pupils enjoy themselves and be interested. I want them to learn while enjoying themselves … and gain the knowledge that I wanted them to learn indirectly. (ETPj)’. The teacher responded that he always makes sure that his classes are interesting so that he could motivate the pupils to learn science. He added, ‘I want the pupils to be excited and happy in my class. I don’t want them to feel bored, instead always looking forward to my lessons’. ETPj stated that he should strategize well so that his classes are always enjoyable so that pupils look forward to his presence in their class and are well motivated to learn science. ETPj believed that pupils should be allowed to communicate and work collaboratively in a group. He reflected his experience with a year 4 class where pupils were instructed to work on a project, ‘One example is with a year 4 pupil. He planted some beans, watered them every day and observed them. Sometimes outside my teaching period, he will come and see me and reported that his bean has sprouted, or gained leaves. Even after I have completed the topic, he still kept and observed the plant…and came to see me one day to report that the plant has wilted.’ He mentioned that by making the pupils work collaboratively to grow seedlings and take care of them, the pupils became motivated and enthusiastic with the project, and reported every detail of the seeds’ growth, even after he had moved on to a new topic.

For most excellent teachers, having good communication during lessons keeps the pupils alert and focused. Pupils should be allowed to ask questions, give ideas and work on the ideas. To encourage good communication, pupils were instructed to work in groups so that they could share ideas and help each other. Some responses from the teachers are: ‘By dividing pupils into multiple intelligence groups...pupils are more willing to share ideas. Some of them are weak, but have good ideas...so they involved themselves and get motivated from group discussions. They like to learn from friends...so I will usually use multiple intelligence groups for activities like projects (ETSw)’. The teacher responded that she divided the pupils into groups of multiple intelligence so that pupils could help each other, support one another with the strength that each individual has so that they could collaborate to complete a given task. She added that, ‘I will ask her to ask her friends, discuss in groups so that she will get the information indirectly from her friends. Friends which are more capable are instructed to help with the tasks. Sometimes I will get friends that have got the answers to help the slower groups. This make my work easier as the pupils learn from their friends’. She believed that by allowing the pupils to work collaboratively as a team, they could discuss and communicate to help each other to improve understanding and work together to solve problems. In doing so, pupils gain experiences and knowledge that allow them to reach a higher level of understanding of the lesson (Anderson, 2001; Vygotsky, 1978).

Excellent teachers are also proficient in choosing a variety of resources for optimum learning. As discussed, being restricted to a certain time and space for learning will prevent pupils from exploring, visualizing and gaining new ideas. The ETs in the study were observed to go beyond classroom teaching and conduct classes outside the classroom or labs. The teachers believed lessons could be conducted using any readily available objects if they are unable to prepare any teaching aids, ‘For example, I will use whatever that is in the classroom as teaching aids, like a pupil’s water bottle.. as long as they are relevant or ask pupils’ existing knowledge on the topic I was about to teach. I would even conduct classes anywhere suitable for the lesson. If the science room is not available, we can have the activities outside the classroom. The T&L of science is not necessarily done in the classroom... it can be conducted under the tree, at the school hall, or the canteen. The teacher needs to be creative and take initiative for it to be done. (ETSw).’ The teacher responded that he would use any readily available objects in the class to discuss a concept and that classes are not restricted to a classroom but any suitable places such as the school hall or the canteen. For example, one excellent teacher has taken the pupils out to the car park to experiment on the frictional forces. Pupils tested
the distance travelled by a toy car when it slides above cement, sand or paved road, and concluded their findings in an inquiry based lesson.

Excellent teachers were observed to use technology effectively for teaching, preparing materials, assessment and communication. An ET responded in an interview that he encouraged pupils to search for information from the Internet before coming to class, or use the Internet to look for information to complete a task. As stated by ETS, ‘I give tasks and ask them to access the information from the Internet’. For ETPj, he would instruct the pupils to search for information on the Internet before he begins the lesson or after completing a lesson, ‘I will usually ask the pupils to search for information from the Internet, pupils from Kuala Lumpur usually have computers at home...After the T&L process, I will instruct the pupils to access the Internet by giving keywords to help them search for information and be focused on the item searched. We can give more tasks for the better pupils.’ As science lessons are conducted in Bahasa Malaysia, the pupils are given keywords to help with their search. ETPj uses multiple technological tools for a single lesson. For example, he began a lesson on defecation and excretion by showing a video of animals defecating, then instructed pupil to google search for ways that fish excrete and later showed a YouTube video of a cat using the toilet. While the teacher finds it hard to get all pupils to use the computer, he compensated for the lack of computers by engaging pupils in the learning process and showed interesting animated video clips. He also reminded the pupils to search for more information from the Internet when they get back home from school.

Some excellent teachers are not as lucky as their urban counterparts as their pupils or schools lack easy access to the Internet or computers. Some of the problems faced are, ‘Some pupils especially the weaker ones usually do not bring any material. Some do not have computer or the Internet at home. So I sometimes bring materials that they can share, discuss in groups and present (ETSw)’ and ‘I have problems with the use of ICT in the T&L process as the school was flooded and all computers could not be used anymore. Anyway, I can still teach effectively by being creative ... use real objects’. The teacher from Sarawak agreed on the importance of using technological tools for teaching, but in reality most of her pupils do not have access to computers and Internet at home. She could not use the school’s computers as they were destroyed when the school was flooded. The teacher claimed that she can still teach effectively by being creative and create a conducive learning environment for her pupils. She believed that by being creative, improvising and using real objects for her teachings, she could create an effective learning environment for science learning. She overcame the problem of pupils not having computers at home by putting them into groups with those who have computers and Internet facility at home.

Teaching for the 21st century skills needs pupils to be actively involved in their learning. However, using technological tools would not guarantee that pupils will be successful, skilful and able to compete globally. Teachers need to revise their role to integrate the technological tools into their lessons so that pupils could gain knowledge and skills crucial for their survival in the 21st century. The following Table 2 shows the trends of instruction of the seven science excellent teachers based on the skills needed for the 21st century learning which are: critical thinking and problem solving, communication, collaboration, creativity and innovation (NEA, 2013).
Table 2 Participant Characteristics

<table>
<thead>
<tr>
<th>21st century skills</th>
<th>Observation</th>
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<tbody>
<tr>
<td>Critical Thinking &amp; problem solving</td>
<td>categorize, compare and contrast, classify, predict, make conclusion, relating, generate ideas, making inferences,</td>
</tr>
<tr>
<td>Communication</td>
<td>good communication between and pupils,</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Conduct group work, multiple intelligences</td>
</tr>
<tr>
<td>Creativity and innovation</td>
<td>innovate for teaching, creative</td>
</tr>
</tbody>
</table>

The findings of the study indicate that excellent teachers in the study have taught pupils to think critically and creatively. However, the critical thinking skills are limited to categorizing, comparing and contrasting, classifying, predicting and making conclusion (KPM, 2011). Pupils were also encouraged to think creatively by relating, generating ideas and making inferences. These skills were gained by the pupils when they seek to answer the questions posed by the teachers, doing inquiry based activities, working in groups to discuss the findings and finally agree on a certain conclusion.

The excellent teachers observed practiced good communication with their pupils. Pupils found the teachers approachable and were willing to ask questions or seek help from the teacher when they were trying to complete a task. Pupils were allowed to communicate well in the classroom, discuss and work together in groups and later present their ideas. They collaborated to complete tasks given and made their own conclusions. Excellent teachers were observed to have encouraged creativity among the pupils by allowing them to create and present their ideas. The analysis of pupils’ work shows that pupils were able to draw mind maps creatively with different styles based on their perceptions of the topic.

Findings of the study indicate that most excellent teachers in this study are able to conduct classes which are student centered. They are able to choose appropriate learning environments that are suitable for the topics and sometimes conduct simple project based activities. One pupil responded, ‘In teacher’s ETP’s classes, he always take us out of the classroom for a walk to visit places. It never happens in our previous classes, we just sit in the class or go to the science room’, indicating the pupil’s preference to learn in multiple learning environments not enclosed in the classroom.

CONCLUSION

The study shows that using technology to aid the learning process depends on the school location. For some schools, the limitations are that they did not have access to computers and Internet to have a completely 21st century learning environment. As mentioned by one of the excellent teachers, some households still do not have computers and Internet, making it impossible to make pupils complete a task or communicate from home. Teachers in the study however, managed to compensate for the absence of technological tools by creating a learning environment that is lively, student centered, contextual and project based. However, this is only true for some excellent teachers, but for others, the teachings are exam oriented where the teachers’ quests are to complete the syllabus and drill pupils for an exam.

Some excellent teachers in the study were observed to have encouraged pupils’ creativity by allowing them to do inquiry and project based activities. The pupils were allowed to explore and discover for themselves the outcomes of their activities and later allowed to design and create based on their understanding. These activities usually involved pupils’ communication, arguments and exchange of ideas.

The findings of the study show that some of the excellent teachers in this study were able to create a learning environment for 21st century learning. Technological tools are well utilized that pupils communicated and collaborated to complete a task in project based learning. Teachers however need to think about how to create a 21st century learning environment so that learning is not confined to a certain
space and time. For teachers in the rural areas, there are no limitations teaching for the 21st century skills. A 21st century learning environment is still possible even with limited technological tools. By adopting the project based or problem based teaching, teachers allow pupils to create and improvise to find ways to complete the given task. To do that, teachers need to be creative, and encourage creative thinking among the pupils, and apply the ideas in the form of innovation or creation of teaching tools.

REFERENCES


