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The Effect of Computerized Feedback on Students' Misconceptions in Algebraic Expression

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ABSTRACT

Misconceptions arise when students fail to link new knowledge to previous knowledge for which the brain has established. Students rely on existing knowledge to solve new problems. If a student holds a misconception, it will interfere with or distorts the assimilation of correct concepts. This study investigated the effect of computerized feedback on students' misconceptions in algebraic expression. A misconception test was computerized and feedbacks were designed accordingly to each response. From the results, there was no significant difference between treatment group and control group students before intervention. After intervention, treatment group students were having lower misconceptions mean score in post-test than in pre-test and the difference was statistically significant. Meanwhile, control group students were having higher misconceptions mean score in post-test than in pre-test and the difference was statistically significant. This shows that there is an effect of computerized feedback on students' misconceptions in algebraic expression. This study pinpoints the advantage of using computer-based test (CBT) in giving immediate feedback to students. This may encourage teachers and educators to use it as a tool to provide detailed and instant feedback to students in a timely manner.

Keywords: Algebraic expressions, computer-based test, computerized feedback, misconceptions

INTRODUCTION

Algebra is a branch of mathematics that substitutes letters for numbers. It uses common arithmetic operations that deal signs and symbols. It is the gatekeeper course to advanced study in mathematics (Robelen, 2013; Welder, 2012). Through algebra, reasoning, thinking, problem solving, patterns, and other skills can be

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developed. However, students always face difficulty and having misconceptions in learning algebraic expression. Algebraic misconceptions can inhibit students from attaining the necessary concepts that are needed to be success in algebra (Russell, O'Dwyer, & Miranda, 2009). Misconceptions occur when students fail to link new knowledge to previous knowledge for which the brain has established cognitive networks (Hiebert & Carpenter, 1992). Once misconception is rooted in students' memory, it is hard to erase. As a result, students are not able to conceptualize the concept well and it influences their cognitive development (Cepni, Tas, & Kose, 2006). Therefore, it is important to let the students know what they did well and what they need to improve. Students should reflect on what they learned, how they learned, why they learned, whether the learning experience could have been more effective, and so on. This can build connections between new and existing knowledge, maximize opportunities for learning and avoid past mistakes. To achieve this, feedback plays an important role. It has been identified as one of the most powerful influences on the learning process (Hattie, 2009).

Research Problem

Nevertheless, the existing findings on the effectiveness of providing learners with different feedback content are rather inconclusive (Narciss et al., 2014). According to the critical review done by Shute (2008), there is large variability of feedback effect on students' learning. The use of feedback comes with its own challenges: how much feedback is needed? When should it be given? (Bokhove & Drijvers, 2012; Marsh, 2012). One of the research gaps to be filled is the mode of feedback presentation. Nowadays, the application of educational technology is spreading fast, various powerful educational tools have been used, including computer-based testing (CBT), which students can be accessed and receive valuable feedback on their performance timely. Present available research does not provide evidence regarding how to integrate feedback in CBT so that it contributes positively to students' misconceptions (Van der Kleij et al., 2012). As learning environment continues to grow in this digital age, this motivates the research question in this study: is there any effect of computerized feedback on students' misconception in algebraic expression?

Research Purpose

To investigate, is there any effect of computerized feedback on students' misconceptions in algebraic expression.

Feedback

Feedback is the information presented to a learner in response to some action on the learner's part. It can be provided by an agent, such as teachers, friends, parents, books, experience regarding one's performance. Conroy et al. (2009) defined feedback as "information provided to children by teachers regarding their understanding or performance of academic or behavioral tasks" (p. 21). Butler and Winne (1995) defined feedback as "information with which a learner can confirm, add to, overwrite, tune or restructure information in memory" (p. 263). Besides, Black and William (1998) defined feedback as "any information that is provided to the performer of any about the performance" (p. 37).

Feedback is an important component in new learning opportunity (Sanchez-Vera et al., 2012). The importance of feedback has been emphasized by educators since last decade (Felder, 1993; Freeman & Lewis, 1998). It is helpful in correcting students' errors (Marsh, 2012). Students like to be assessed and get value comments on their achievement (Lilley, Barker, & Britton, 2005). This is supported by Gibbs (1999) that "*learners require feedback in order to learn*" (p. 46). Also, supported by Economides (2006) that feedback produced significant benefits in learning and achievement across all content areas, knowledge and skill types, and levels of education. It has powerful influences on students' learning and achievement, and helps teachers to design learning content according to students' need (Hattie & Timperley, 2007; Matthews et al., 2012; Sanchez-Vera et al., 2012). It also can reduce the discrepancy between current and desired understanding (Hattie & Timperley, 2010).

Effective Feedback

Although feedback offers numerous advantages, the way it is given can be differentially effective. For feedback to be effective for students, it has to be deployed in a structured and meaningful manner (Chan & Leijten, 2012). Generally, effective feedback needs to be clear, purposeful, meaningful, and detailed in content (Bridge & Appleyard, 2005; Denton et al, 2008). Feedback must give affirmation of what students can currently do, what error they made, and what they need to do next to improve their understanding (Hattie & Timperley, 2007; Yorke, 2003). Avoid using judgmental feedback but constructive feedback that emphasizing on positive part, rather than negative part (Lalor, 2012). Meanwhile, strategies and direction should be given to help the students to improve. Also, feedback given to students must be in a timely manner (Hattie & Timperley, 2007; Mutch, 2003). Based on information and interpretation from literature review, a feedback structure has been proposed with the following stages in this study (Table 1).

Table 1
Component and criteria of effective feedback

Component	Details
Correctness	Telling the student about the correctness of the question. Examples: (a) Well done, the correct answer is "A". (b) The correct answer is "A", keep it up!
Information	Telling the student about the learning outcome of the question. Examples: This question is to identify unknowns in algebraic terms in two or more unknowns.
Reinforce	Reinforce what the student did well/error needs to be improved. Examples: (a) You are able to identify 3*ab*, where *a* & *b* are unknowns. (b) Do you know that 3*ab*, where *a* & *b* are unknowns?

Table 1 *(continue)*

Component	Details
Directive Guide	Showing the correct solution
Common Criteria	(a) Immediate feedback
	(b) Clear and easy to be understood
	(c) Positive component

Theoretical Framework

The theory used as the basic for this study is Ohlsson's Theory of Learning from Performance Errors (Ohlsson, 1996). There are two key components in learning from performance errors: (a) declarative knowledge and (b) procedural knowledge. Declarative knowledge is descriptive and use-independent. It consists of facts and principles. For example, the laws of distribution and the laws of multiplication. It is important in providing generality. Meanwhile, procedural knowledge is prescriptive and use-specific. It consists of association between goals, situations, and actions. For example, procedure for simplifying algebraic expression and explanatory strategies in biology. It is important in generating and organizing an action.

Declarative knowledge is dissociated with procedural knowledge as knowing *that* and knowing *how* is distinct. A student might has the declarative knowledge required to judge a performance as incorrect, but lack of the procedural knowledge required to perform better. Therefore, it is not surprising that students often did errors when they perform a task even if they have been taught the correct way. This is because their declarative knowledge has not been converted to procedural knowledge (Lee, 2008). Learning starts with accumulating declarative knowledge. It is then later converted into procedural knowledge through practice. When procedural knowledge is missing or is faulty, errors occur (Mitrovic, 2010).

The basic principles of this theory stated that errors are experienced as the conflicts or discrepancies between actual outcomes (correct answer) with the expected outcomes (incorrect answer). Ohlsson (1996, p. 242) defined error as "*inappropriate actions committed while performing a task*." It can be defined as deviation from the correct solution as well. Although humans have the innate ability to catch themselves making errors, this ability has imperfections (Gilovich, 1991; Ohlsson, 1996). The ability to recognize an error is complex. Consequently, anyone can make a mistake. There are two phases in the process of learning from errors: (a) error detection and (b) error correction.

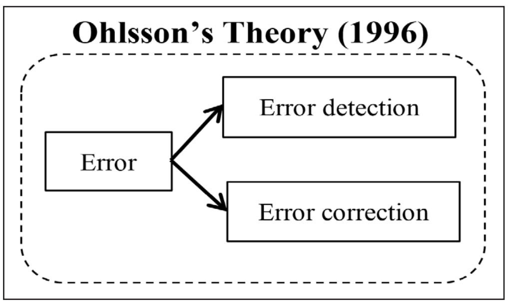

Figure 1. Ohlsson's theory (1996).

Ohlsson (1996) stated that it was paradoxical to hypothesize that learners could detect errors with the help of previous knowledge. A student would not perform an error in the first place if he or she has enough knowledge to recognize a particular action as incorrect. Errors are recognized through particular features of the situation they produced that indicate incorrect actions, so-called error-signals. It requires domain-specific declarative knowledge. For example, to recognize errors in simplifying an algebraic expression, a student must have some knowledge about like terms and unlike terms in algebraic expressions.

Error correction refers to the removal of an error from the existing knowledge in order to have improvement in future actions. It consists of three cognitive processes (Ohlsson, 1996; Petkova, 2008) as follows:

1. Blame assignment—the process of identifying the factors that contributes to an unexpected outcome (incorrect action and faulty rule) in a particular context.
2. Attribution of bad outcomes or error attribution—attributing errors to a particular action or identifying the situation that interacted with an action to produce an undesirable outcome.
3. Revision of faulty knowledge structures—repairing the error.

Learners must be aware of their errors in order to learn from them. If a student never learns what his or her errors are, he or she will never correct them. An error only can be corrected after it is detected. If a student does not possess such declarative knowledge, a feedback may play the role of a mentor and informs the student of his or her errors (Mitrovic, 2010). Feedback given during learning process can improve students' further performance by providing them an opportunity to learn from their errors (Randall & Zundel, 2012). A carefully designed feedback that reflects the action of a human teacher, helps the student to overcome problems in his or her knowledge. It can come from the environment itself or teacher, either a human or an artificial one.

METHODS

Participants and Design

A total of 120 Grade 7 students were involved in this study due to purposive sampling. Furthermore, it was also based on the suitability of syllabus. They were grouped into two independent groups as described in Table 2. Due to the school permission restraint to keep existing classrooms intact, this study used a pre-test/post-test quasi experimental design rather than true experimental design to investigate the effect of feedback. This is one of the most common quasi-experimental designs, which similar with the classic controlled experimental design, except that the participants are not randomly assigned to either control or treatment group.

Table 2
Demographic variables of the study

Group	Gender		Total	Percentage (%)
	Male	Female		
Control	49	7	56	47
Experimental	20	44	64	53
Total	69	51	120	100

Instrument

Algebraic Expression Misconceptions Test (AEMT) I and II. Two parallel forms of Algebraic Expression Misconceptions Test (AEMT I: Pre-test and AEMT II: Post-test) were constructed based on Grade 7 Mathematics syllabus in Malaysia. The test covers one learning objective: understand the concept of algebraic expression. It is further divided into three learning outcomes that consist of three cognitive levels (according to Bloom's taxonomy): (a) low ledge: recognize algebraic expression; (b) understanding: determine the number of terms in given algebraic expressions; (c) application: simplify algebraic expression by combing the like terms. In total, 22 items were constructed by referring to textbook and reference books published locally. The allocated time for the test is 40 min. The test specification is shown in Table 3.

Table 3
Test specification

Learning Objective	Learning Outcomes	Cognitive Level*	Items	Selected-Response Items
Understand the concept of algebraic expressions	1. Recognize algebraic expressions.	One (Knowledge)	1–5	Binary
	2. Determine the number of terms in given algebraic expressions.	Two (Understanding)	6–10	Multiple choices
	3. Simplify algebraic expressions by combining the like terms.	Three (Application)		
	a. One unknown		11–16	Multiple choices
	b. Two unknowns		17–22	Multiple choices

* According to Bloom's Taxonomy

Distractor Setting

Good quality of distractors can ensure the credibility and objective picture of the test. Poor distractors would affect the accuracy of the test (Mkrtchyan, 2011). Writing plausible distractors is one of the most difficult aspects in composing question. The distractors used should be plausible and attractive to be selected by students who did not achieve the learning outcome but ignored by students who did achieve the learning outcome. Hence, distinguishing can be made between high-performing and low-performing students. To build good distractors, a pilot study was carried out.

A total of 50 Form One students were involved in the pilot study. To gather information of their existing misconception, they were tested with AEMT I in the form of open-ended items through paper-and-pencil test. They were required to write down their solution on the test paper provided. From the pilot test result, there are three major misconceptions found in simplifying algebraic expressions:

1. **Misconception with letter usage and conjoin error:** associate letters with their positions in alphabet. For example, interpret $8b$ as short for "8 boys." This is further transformed into an algebraic expression for $3b + 5b$ as 3 boys added to 5 boys. In turn, read $3c$ as 3 and c, and interpret it as $3 + c$.
2. **Misconception with bracket usage:** omit to use distributive law in arithmetic. For example, for $3(a + 7)$, students performed in such way: $3(a + 7) = 3(7a) = 21a$, rather than: $3(a + 7) = 3 \text{ x } a + 3 \text{ x } 7 = 3a + 21$.
3. **Misconception with negative integers:** students believed that negative signs represent only the subtraction operation and do not modify terms. For example, made detachment from the negative sign error, such as interpret $-6x + 3x$ as $-(6x + 3x)$ and further simplify it is $-9x$.

Possible answers resulted from the three common misconceptions found were used as distractors in the items in AEMT. Therefore, it is reasonable to assume that AEMT can be used to diagnose students' misconception. If a student is having misconception in letter usage and conjoin error, he or she will choose option B as the answer, and so for the other two misconceptions. Through this, all three misconceptions can be identified.

Computer-Based Test

Algebraic Expression Misconceptions Test I (AEMT I) was transformed into CBT test by using XAMPP and phpMyAdmin. Computerized feedback was presented to each group of students after an answer was clicked. For treatment group students, detailed feedback that comprised of the four elements was shown. For control group students, simple feedback (showing correct/incorrect) was shown.

Procedure

There were three main sessions involved in this study. Session 1 consisted of pre-test (AEMT I), it was administered to all the participants in the form of paper-and-pencil test (PPT) to determine their achievement in algebraic expression before the intervention.

Session 2 consisted of intervention phase. During this session, both control group and treatment group students took the CBT. For control group, only simple feedback was presented after every question was answered. For example: "correct" or "wrong." For treatment group, detailed feedback was presented, which consists of the four elements as shown in Table 1. Session 3 consisted of post-test (AEMT II). To avoid testing effect, the items on the post-test were isomorphic equivalents of the pre-test items.

Before each test was started, clear instructions were given by researchers to both teachers and students involved. Students were informed that the result will not be taken into account as a part of the evaluation in their study. The highlight of this point is to gain students' confidence about the confidentiality of the questionnaire and avoid dishonesty. Respondents were allowed to ask questions before the test was started. Time allocated for each test was 40 min. During the test, students were not allowed to talk and discuss with others. They were required to answer honestly and answer all the questions within the allocated time.

RESULTS

As the distractors in AEMT were designed according to students' misconception as discussed, the students' responses indicated that they held misconceptions in algebraic expression. Table 4 shows the treatment and control group students' responses in selecting correct answer and different misconceptions in both pre-test and post-test.

Table 4
Results of pre- and post-test concerning misconceptions

Responses	Treatment Group				Control Group			
	Pre-test		Post-test		Pre-test		Post-test	
	n	%	n	%	n	%	n	%
*Correct Answer	241	75	291	91	198	71	179	64
Misconception 1: Recognizing algebraic expression	79	25	29	9	82	29	101	36
*Correct Answer	202	63	243	76	148	53	123	44
Misconception 2: Determining the number of terms in given algebraic expressions	118	37	77	24	132	47	157	56
*Correct Answer	169	22	238	31	151	22	168	25
Misconception 3: Bracket usage	220	29	175	23	162	24	184	27
Misconception 4: Letter usage and conjoin error	186	242	142	18	168	25	170	25\2
Misconception 5: Negative integers	193	5	213	28	191	28	150	2

(n = number of entry; % = percentage)

Based on the number of entry, the mean scores for all the misconceptions were summarized and further examined by carrying out paired-samples *t*-test. Table 5 shows the results of paired samples *t*-test for the treatment group concerning misconceptions.

Table 5
Treatment group: Paired-samples t-test concerning misconceptions

Group	Misconception	N	Pre-test		Post-test		Paired differences								
							Pair	Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference		*t*	df	Sig. (two-tailed)
			Mean	SD	Mean	SD					Lower	Upper			
Treatment	M1	64	1.23	0.527	0.45	0.532	Pre-test and post-test	0.781	0.548	0.069	0.644	0.918	11.4	63	0
	M2	64	1.84	0.479	1.2	0.78	Pre-test and post-test	0.641	0.784	0.098	0.445	0.836	6.536	63	0
	M3	64	3.44	0.639	2.73	0.802	Pre-test and post-test	0.703	0.849	0.106	0.491	0.915	6.629	63	0
	M4	64	2.91	0.75	2.22	0.745	Pre-test and post-test	0.688	1.052	0.132	0.425	0.95	5.227	63	0
	M5	64	3.02	0.766	3.33	0.818	Pre-test and post-test	−0.313	0.664	0.083	−0.478	−0.147	−3.767	63	0

*The higher the mean score, the higher the level of misconceptions
*M1= Misconception 1: Recognizing algebraic expression; M2 = Misconception 2: Determining the number of terms in given algebraic expressions; M3 = Misconception 3: Bracket usage; M4 = Misconception 4: Letter usage and conjoin error; M5 = Misconception 5: Negative integers

Based on the results, treatment group students were having lower misconceptions mean score in post-test than in pre-test for all the misconceptions except for M5.

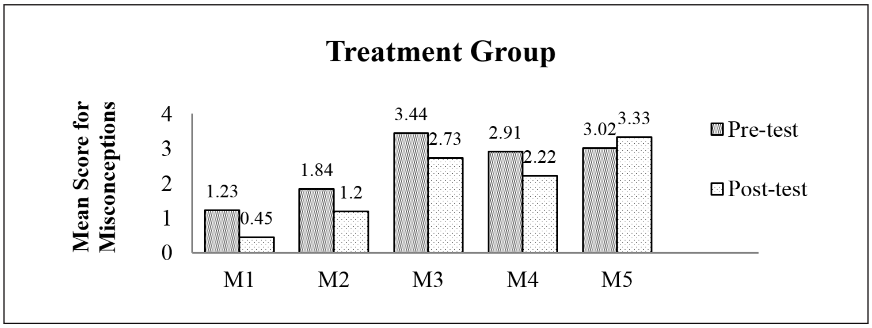

Figure 2. Treatment group (mean score for misconceptions in pre- and post-test).
*M1= Misconception 1: Recognizing algebraic expression; M2 = Misconception 2: Determining the number of terms in given algebraic expressions; M3 = Misconception 3: Bracket usage; M4 = Misconception 4: Letter usage and conjoin error; M5 = Misconception 5: Negative integers

Meanwhile, similar analysis was carried for control group, to see the effect of feedback on their misconceptions in algebraic expression. Table 6 shows the results of paired samples *t*-test for the control group concerning misconceptions.

Based on the results, control group students were having higher misconceptions mean score in post-test than in pre-test for all the misconceptions except M5. The difference between means was statistically significant for all the misconceptions, except for M4.

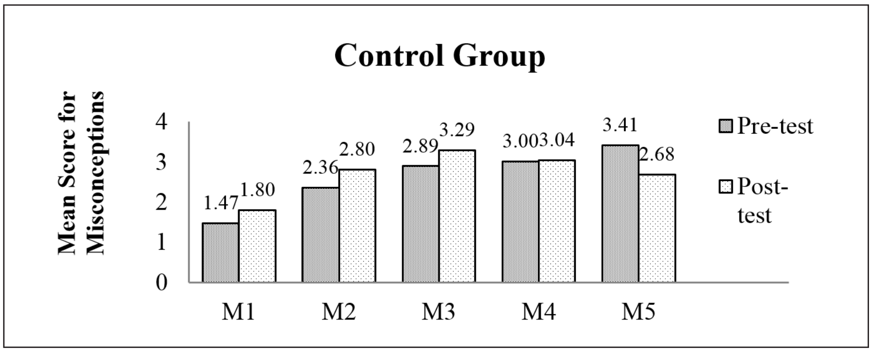

Figure 3. Control group (mean score for misconceptions in pre- and post-test).
*M1= Misconception 1: Recognizing algebraic expression; M2 = Misconception 2: Determining the number of terms in given algebraic expressions; M3 = Misconception 3: Bracket usage; M4 = Misconception 4: Letter usage and conjoin error; M5 = Misconception 5: Negative integers

Table 6
Control group: Paired-Samples t-*test concerning misconceptions*

Group	Misconception	N	Pre-test		Post-test		Paired differences								
			Mean	SD	Mean	SD	Pair	Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (two-tailed)
Control	M1	56	1.46	0.602	1.8	0.699	Pre-test and post-test	−0.339	0.859	0.115	−0.569	−0.109	−2.957	55	0.005
	M2	56	2.36	0.749	2.8	0.724	Pre-test and post-test	−0.446	1.025	0.137	−0.721	−0.172	−3.258	55	0.002
	M3	56	2.89	0.888	3.29	1.057	Pre-test and post-test	−0.393	1.358	0.181	−0.756	−0.029	−2.166	55	0.035
	M4	56	3	0.786	3.04	0.894	Pre-test and post-test	−0.036	1.25	0.167	−0.370	0.299	-−0.214	55	0.831
	M5	56	3.41	0.987	2.68	0.936	Pre-test and post-test	0.732	1.152	0.154	0.424	1.041	4.756	55	0

*The higher the mean score, the higher the level of misconceptions
*M1= Misconception 1: Recognizing algebraic expression; M2 = Misconception 2: Determining the number of terms in given algebraic expressions; M3 = Misconception 3: Bracket usage; M4 = Misconception 4: Letter usage and conjoin error; M5 = Misconception 5: Negative integers

DISCUSSION AND CONCLUSION

The findings reveal that there is an effect of computerized feedback on students' misconceptions in algebraic expression. After the intervention, treatment group students were having lower misconceptions mean score in post-test than in pre-test for all the misconceptions except for M5. The difference between means is statistically significant for all the misconceptions. Meanwhile, control group students were having higher misconceptions mean score in post-test than in pre-test for all the misconceptions except M5. The difference between means is statistically significant for all the misconceptions, except for M4.

Misconceptions arise when students fail to link new knowledge to previous knowledge for which the brain has established (Lucariello, Tine, & Ganley, 2014). The existence of misconception triggers the occurrence of errors (Smith, Disessa, & Roschelle, 1993). According to Ohlsson (1996)'s theory, there are two phases in the process of learning from errors: (a) error detection and (b) error correction. Learners must be aware of their errors in order to learn from them. If a student never learns what his or her errors are, he or she will never correct them. Before an error can be corrected, it must first be detected. Meanwhile, feedback plays the role of a mentor and informs the students of the error. As reported by Barrow et al. (2008), the number of errors made by students could be reduced by providing feedback to them. It is supported by Marsh (2012) that feedback is useful in correcting students' errors. Therefore, treatment group students were able to identify and correct their errors after reading the feedback presented. In turn, solve their misconceptions and improve their performance.

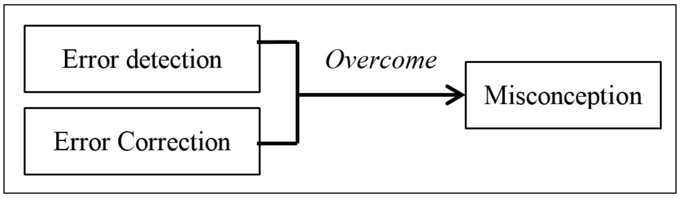

Figure 4. Error and misconception.

This is further supported by Adams et al. (2014) that attending to students' error is helpful to assist them learn from errors and overcome their misconceptions. Similarly, Chen, Hsieh and Hsu (2007) and Lee, Lee and Leu (2009) expressed that feedback allows students to receive useful hints that lead to identification of their misconceptions. In turn, it provides opportunity for them to solve their misconceptions. A recent study by Lin, Lai and Chuang (2013) supported this. Their findings showed that feedback provided hints that helped students to rectify their misconceptions. Another finding that is in line with this is the study by Cotner, Baepler and Kellerman (2008). They commented that feedbacks encouraged students to identify and help them to untangle their misconceptions, which might lead to their improved exam performance.

Meanwhile, Leijen et al. (2012) pointed out that feedback enabled individuals to share and learn from others' perspectives, interpret and develop their own perspectives. Then, learners could establish connections between new and existing knowledge, to understand their own position within that relationship and improve it. Therefore, maximize the opportunities for learning and avoid past mistakes. This could be another reason that computerized feedback is effective in resolving students' misconceptions.

Besides, the timeliness of computerized feedback might contribute to its effectiveness in resolving students' misconceptions. In this study, feedback was delivered to students through CBT. The purpose of using CBT as the feedback delivery medium is to present feedback to students in a timely manner. Through CBT, students were assessed and received feedback in a timely manner. According to Mutch (2003), it was important to give feedback to students within certain timelines when it was still meaningful to them. Students who received immediate feedback showed higher response identification accuracy, confidence rating, and memory retention (Brosvic et al., 2005). They appreciated prompt feedback that could reveal misconceptions and convert their mistakes to correct answers (Cotner et al., 2008; Epstein et al., 2002). The finding of this study is also in line with Carter (1984) that the timing of feedback should be immediate to provide remedial information constantly and avoiding confusion (Siegel & Misselt, 1984).

Nevertheless, among the five misconceptions involved, the effect of feedback on students' misconceptions is inconclusive. The distractors used in the pre-test and post-test are possible answers resulted from misconceptions by referring to literature review and pilot study result, as stated earlier. After the intervention, treatment group students were having lower misconceptions mean score in post-test than in pre-test for all the misconceptions except for M5. Interestingly, control group students were more likely to select responses formed by all the misconceptions in post-test than in pre-test, except for M5. Although the feedback is useful in resolving students' misconceptions, this is invalid for M5: Negative integers. This lightens up the idea that the effectiveness of feedback in resolving students' misconceptions is influenced by the type of misconceptions. The feedback might works differently under certain aspects for different misconceptions. Algebraic misconceptions have been investigated by many researchers and they were being categorized into different groups, such as the meaning of algebraic letters, algebraic expression, negative integers, variables in algebraic, equations, and order of operations (Eccius-Wellmann, 2012; Lim, 2010; Luka, 2013, Perso, 1991). However, algebraic misconceptions are not being assessed and arranged according to their difficulty levels. The inconclusive effect of feedback on students' misconceptions in this study triggers the idea that misconceptions might differ in terms of complexity or difficulty. Because solving misconceptions involves cognitive process that ranging from low to high cognitive levels, it is reasonable that misconceptions can be arranged or classified according to its difficulty. In the other words, lower cognitive skills needed to solve easier misconceptions and higher cognitive skills are needed to solve harder misconceptions. The findings of this result suggest that M5 is more complex and most difficult compared to the other four misconceptions. Students who possess this misconception were not able to resolve it after receiving the feedback. The reason behind is worth for deeper investigation in future study.

In summary, it can be concluded that there is an effect of computerized feedback on students' misconceptions in algebraic expression. However, its effect varies according to different types of misconceptions in some extent.

Theory Implication

The theoretical framework in this study highlights the role of Ohlsson's theory - Learning from Performance Errors (1996) in explaining the effect of computerized feedback. According to Ohlsson, there are two key components in learning: (a) declarative knowledge and (b) procedural knowledge. Knowing *that* (declarative knowledge) and knowing *how* (procedural knowledge) is distinct. The findings of this study supported this. Control group students received simple computerized feedback that allows them to know whether their answer is correct or wrong (declarative knowledge). Meanwhile, treatment group students received detailed computerized feedback that not only showing them the correct answer but also showing them the proper solution to solve the question. This helps them to detect their errors and convert their declarative knowledge into procedural knowledge. In turn, they performed better than control group students.

Learners must be aware of their errors in order to learn from them. If a student never learns what his or her errors are, he or she will never correct them. With quality feedback during learning process, valuable information could provide students an opportunity to learn from their errors. As supported by Alphert-Sleight (2003) that learners must have informative task environment in order to detect and correct errors. They learn a skill by detecting and correcting errors while performing the skill.

Attending to students' errors is necessary in improving their learning. As highlighted in the theory, an error only can be corrected after it is detected. Through feedback, it provides opportunity to students to think and reflect their levels in knowledge construction (Aronson, 2011; Duffy, 2009). As supported by Randall and Zundel (2012) that feedback given during learning process can further improve students' performance by providing them an opportunity to learn from their errors. It functions as an error signal to let the students are aware of their errors. While feedback is useful in students' learning, emphasizing error detection and error correction in feedback makes feedback even more powerful. The results of this study pinpoint the possibility of integrating theoretical knowledge into real classroom practice. As errors play an important role in the effectiveness of feedback, this reminds teachers and educators to emphasize on students' errors when giving feedback. What they did wrong should be pointed out for them to think and understand their errors and avoid past mistakes in the future.

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