Asia Pacific Journal of Educators and Education, Vol. 30, 141–158, 2015

THE EFFECTS OF INSTRUCTION USING THE ARCS MODEL AND GEOGEBRA ON UPPER SECONDARY STUDENTS' MOTIVATION AND ACHIEVEMENT IN LEARNING COMBINED TRANSFORMATION

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Abstract: The purpose of this study was to investigate upper secondary students' motivation and achievement through instruction using the Geogebra by integrating Attention, Relevance, Confidence, and Satisfaction (ARCS) strategies. Specifically, it sought to investigate Form Four students' motivation and achievement of combined transformation before and after the instruction using Geogebra, whether there was any significant difference in students' motivation and achievement after the intervention and what influenced their motivation in learning transformation. An exploratory case study research design was employed. The study sample comprised of 24 Form Four students from a secondary school in Selangor. Course Interest Survey (CIS) and Transformation Geometry Test (TGT) were employed to access students' motivation and achievement before and after the intervention; semi-structured interview was employed to probe the influences on the students' motivation after intervention. Both the paired-samples *t*-test and Wilcoxon test indicated significant differences in students' achievement ($t = -10.025$, df = 23, $p < .05$) and motivation ($Z = -4.287$, $p < .05$) after the intervention. Also, this result was further enhanced by the analysis of interview transcripts, which suggested that "learning experience", "learning enhancement" and "interactive learning" were the themes inferred from the participants' interviews.

Keywords: ARCS, instruction, Geogebra, CIS, combined transformation

Abstrak: Tujuan kajian ini adalah untuk meningkatkan tahap motivasi dan pencapaian pelajar-pelajar sekolah menengah atas melalui pengajaran dengan menggunakan Geogebra melalui integrasi strategi *Attention, Relevance, Confidence,* dan *Satisfaction* (ARCS). Secara khususnya, kajian ini mengkaji motivasi dan pencapaian pelajar Tingkatan Empat tentang gabungan penjelmaan sebelum dan selepas pengajaran dengan menggunakan Geogebra, dan sama ada terdapat perubahan yang signifikan dalam motivasi dan pencapaian selepas intervensi serta mengenal pasti kesan-kesan terhadap motivasi pelajar dalam pembelajaran gabungan penjelmaan. Pengkaji menggunakan reka bentuk kajian kes eksploratori dan sampel kajian terdiri daripada 24 orang pelajar Tingkatan Empat dari sebuah sekolah menengah di Selangor. *Course Interest Survey* (CIS) dan *Transformation Geometry Test* (TGT) digunakan untuk menilai motivasi dan pencapaian pelajar sebelum dan selepas intervensi; temu duga separa-berstruktur digunakan untuk meneroka pengaruh-pengaruh terhadap motivasi pelajar selepas intervensi. Kedua-dua *paired-samples t*-test dan ujian *Wilcoxon* menunjukkan perbezaan yang signifikan terhadap pencapaian pelajar ($t = -10.025$, df = 23, $p < .05$) dan motivasi pelajar ($Z = -4.287$, $p < .05$) selepas intervensi dijalankan. Malah, keputusan tersebut diintensifkan oleh transkrip temu duga dengan mencadangkan tema-tema "*learning experience*", "*learning enhancement*" dan "*interactive learning*" yang disimpulkan dari temu duga pelajar-pelajar.

Kata kunci: ARCS, pengajaran, Geogebra, CIS, gabungan penjelmaan

BACKGROUND OF THE STUDY

Learning geometry is important as it has been identified as one of the components of essential mathematics, which is essentially viewed as the competencies that a student needs for future employment and education (National Council of Supervisors of Mathematics, 1989). Learning geometry is an important skill in the application to real life problems and is highly interconnected with other mathematic topics (National Council of Teacher of Mathematics, 2000). In Malaysia, the two-dimension and three-dimension are formally introduced in Year One under Mathematics syllabus *Kurikulum Standard Sekolah Rendah* (KSSR) (Malaysian Ministry of Education, 2011).

Despite its importance in mathematics, Malaysian 8th Grade students (equivalent to Form Two level) performed unsatisfactorily in the Trends International Mathematics and Sciences Study (TIMSS) 2011 report. The average geometry achievement of Malaysian 8th Grade students (432) was far behind their counterparts in Asia-Pacific countries, such as Chinese Taipei (625), Republic of Korea (612), Singapore (609), Hong Kong (597) and Japan (586) (Mullis, Martin, Foy, & Arora, 2012). In addition, the average geometry scale score for Mathematics in 8th Grade level, Malaysia dropped a hefty 65 score points from 497 in 1999, 495 points in 2003, 477 points in 2007 to 432 points in 2011. The low scores of Malaysian 8th Grade students indirectly reflected the need to improve teaching and learning strategies of geometry.

Learning geometry is not an easy process and is deemed as a major concern in mathematics education (Fuys, Geddes, & Tischler, 1988). Subsequently, local researchers had shown that students in middle and high schools are facing difficulties in learning geometry (Chew, 2007; Hong, 2005). This is because learning geometry is highly abstract and difficult to understand (Van Hiele-Geldof, 1957/1984; Tahta, 1990). Without an appropriate pedagogical strategy in teaching and learning, the students will copy by memorising theorems and proofs (Choi-koh, 2000). The fundamental of the proposed pedagogical guide is to relate the learned geometry knowledge to the real world and its application in real life. As a result, technology is recommended as the "tool to facilitate the process of bringing the real life application of geometry to the abstract geometry thinking and challenge the cognitive process in problem solving" (Koo, Teoh, Ahmad, & Khairul, 2009, p. 2). In relation to this study, Geogebra as an open source software was used as the technology tool not only to facilitate the process of learning geometry but also for the creation of geometry constructions as well as interactive exploration through dragging.

Furthermore, Effandi and Zanaton (2007) noted that Malaysian mathematics teachers prefer to use traditional approaches in the classroom: a lecture-based approach and teacher-centred approach. Generally, a lesson begins with the teacher explaining mathematical ideas, showing the ways to solve typical related questions and followed by practicing some selected exercises in the textbook. In addition, TIMSS 2011 reported the same fact that the most dominant activities in mathematics classroom were teacher lecture, teacher-guided and textbook as the primary material of their lessons (Mullis et al., 2012). In such a teaching and learning environment, students become passive learners and resort to rote learning. They are seldom given the chance to ask and develop conceptual understanding because teachers and the public at large still believe that learning mathematics consists of a set of procedures and telling students how to perform these procedures instead of self-exploring learning (Battista, 1994). Although students initially viewed mathematics as an interesting subject and wished to explore further, they realised that they were being taught in a passive learning mode. As a result, students feel mathematics is a boring and difficult subject to learn because they are forced to receive knowledge passively and rote memorise the standard procedures. This scenario brings attention to learning mathematics, particularly geometry in secondary school.

Many mathematics teachers realise the importance of incorporating motivation in instructional learning because it can affect both learning and performance as motivation has a reciprocal relation to learning and performance (Schunk & Pintrich, 1996). Consequently, educators and teachers realise that they not only have to focus on the cognitive domain, but also other domains when preparing instructional materials (Main, 1992). However, the focus on affective objectives and motivation is always neglected in the course and instructional designs (Keller, 2010). In the work on grading student differences in learning, most of the teachers choose to focus on cognitive objectives although the student's achievement is blended with conative or motivation aspect (Snow, Corno, & Jackson, 1996).

Essentially, Lim (2001) noted the impact of the ignorance of mathematics teachers in inspiring and making mathematics lessons enjoyable. The research was conducted on 548 adults who responded to questionnaires and 62 of them were interviewed. The research showed that the respondents disliked mathematics, mainly because they found mathematics to be boring, difficult and irrelevant to their life. Subsequently, it influenced their course and career choice, as well as their children's future course. Additionally, the Institute for Democracy and Economic Affairs (IDEAS) reported that 72% of respondents who dropped out of school mentioned lack of interest in school as the main reason for discontinuing schooling (Patel, 2014). Thus, this report is an indirect reflection of the urgent need for mathematics teachers to learn the ways of structuring pedagogy to make the lessons more interesting, relevant and engaging for students.

Clearly, the call for conclusive research on the relations between cognitive and motivation domains is warranted. However, there is little research on the effectiveness of incorporating motivation strategies towards motivation and achievement via Geogebra in learning geometry, specifically combined transformation. The motivational aspect of upper secondary students has often been overlooked because so much attention has centered on the cognitive achievement, particularly on school examinations and public examinations. Knowledge gained from this study will eventually assist mathematics teachers in planning instruction by incorporating motivation strategies and as vital information for producing students with high level of cognitive achievement, as well as great interest in the subject being taught.

PURPOSE OF THE STUDY

The purpose of this study was to investigate the effects of instruction using ARCS model and Geogebra on upper secondary students' motivation and achievement as well as how the instruction influences their learning. Thus, the following research questions were formulated in an effort to answer the purpose mentioned:

1. Is there a significant difference in the students' achievement after the intervention?
2. Is there a significant difference in the students' motivation after the intervention?
3. How does the instruction influence the students in learning combined transformation?

THEORETICAL FRAMEWORK

According to the Attention, Relevance, Confidence, and Satisfaction (ARCS) theory of motivation postulated by John Keller, a learner's motivation can be stimulated through instruction by creating conditions that will arouse the learner's desire to be interested in order to achieve their goal (Keller, 1987). In education, there has been a lack of attention and resources in developing the motivational aspects of learning. Therefore, he introduced a systematic approach for integrating motivation into the instructional design in answering the question of "how to develop a learning environment that will stimulate and sustain learners' motivation" (Keller, 2010, p.194).

Besides that, Keller's ARCS model provides four categories of motivational concepts based on a comprehensive review of the literature on motivation. The acronym ARCS refers to an overview of the major dimensions of human motivation: Attention, Relevance, Confidence, and Satisfaction. Table 1 depicts the definitions and process questions of the ARCS model.

Table 1. ARCS model categories, definitions, and process questions

Major Categories	Definitions	Process Questions
Attention	Capturing the interest of learners; stimulating the curiosity to learn	How can I make this learning experience stimulating and interesting?
Relevance	Meeting the personal needs/ goals of the learner to effect a positive attitude	In what ways will this learning experience be valuable for my students?
Confidence	Helping the learners believe/ feel that they will succeed and control their success	How can I via instruction help the students succeed and allow them to control their success?
Satisfaction	Reinforcing accomplishment with rewards (internal and external)	What can I do to help the students feel good about their experience and desire to continue learning?

Source: Adapted from Keller (2010)

METHODOLOGY

Sample

An exploratory case study research design was employed in this research (Yin, 2003) to enhance the quantitative data and provide insight on how the intervention influences students' motivation in learning combined transformation. The sample was selected based on the purposeful sampling method because the purpose of the case study was not to generalise the result to the population. An intact class of 24 Form Four students with mix-ability was chosen for this study. The sample had three criteria. First, the sample comprised of Form Four students who had not learnt combined transformation. Second, the sample possesses basic skills in using computer to be able to use the application of Geogebra software. Third, there were no age differences between the students.

Instrument

The achievement for learning combined transformation

In this study, achievement was operationalised using Transformation Geometry Test (TGT). The 8-item multiple-choice and 2-item subjective paper-and-pencil achievement test was devised by the researcher to assess students' achievement in learning single and combined transformation (see Table 2). The 8-item for multiple-choice test assessed the learner's prior knowledge in a single transformation (translation, reflection, rotation and enlargement), which they had learned during lower secondary (see Figure 1). The items for subjective questions assessed the learner's application of two single transformations to form the combined transformation (see Figure 2). The TGT required about 30 minutes to be completed and yielded a reliability coefficient of 0.747. Also, TGT was validated by two experienced mathematics teachers who have more than 20 years in teaching mathematics for its content validity.

Table 2. Distribution of items in Transformation Geometry Test (TGT)

Concept	Type of Transformation	Type of Question	Question Number	Score
Single transformation	Rotation	Multiple-choice	1	2
	Translation	Multiple-choice	2	2
	Reflection	Multiple-choice	3	2
	Enlargement	Multiple-choice	4	2
	Rotation	Multiple-choice	5	2
	Enlargement	Multiple-choice	6	2
	Translation	Multiple-choice	7	2
	Reflection	Multiple-choice	8	2
Combined transformation	c	Subjective	9 (a) (i)	2
	c	Subjective	9 (a) (ii)	2

(continue to next page)

Table 2. *(continued)*

Concept	Type of Transformation	Type of Question	Question Number	Score
Combined transformation	e	Subjective	9 (b) (i)	3
	e	Subjective	9 (b) (ii)	2
	g	Subjective	9 (c)	3
	b	Subjective	10 (a) (i)	1
	b	Subjective	10 (a) (ii)	1
	d	Subjective	10 (a) (iii)	1
	b	Subjective	10 (b) (i)	2
	f	Subjective	10 (b) (ii)	3
	a	Subjective	10 (c)	4
			Total	40

a. To determine the image of an object under a combination of two transformations
b. To draw the image of an object under a combination of two transformations
c. To state the coordinate of the image of a point under the combined transformation
d. To determine whether the combined transformation AB is equivalent to the combined BA
e. To specify the two successive transformations in a combined transformation when object and image are given
f. To describe a single transformation, which is equivalent to the combination of two isometric transformations
g. To solve problems involving transformation

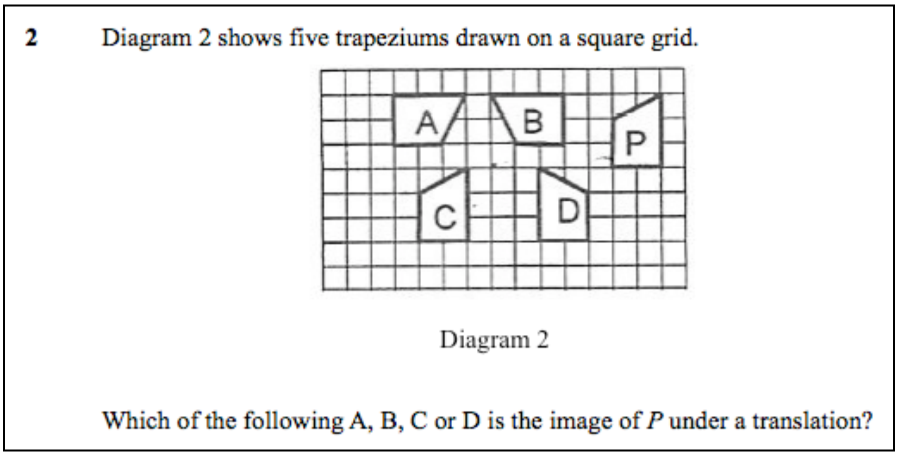

Figure 1. Sample of multiple-choice item

9 Diagram 9 shows three pentagons, *ABCDE, PQRST* and *VQWXY*, drawn on a Cartesian plane.

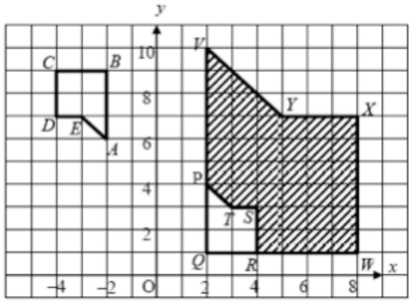

Diagram 9

(a) Transformation **M** is a translation $\begin{pmatrix} 1 \\ 3 \end{pmatrix}$ and transformation **N** is clockwise rotation of 90° about centre *A*.

State the image of point (0, 3) under transformation

(i) **NM**

(ii) **MN** [4 *marks*]

Figure 2. Sample of subjective item

The motivation for learning combined transformation

The Course Interest Survey (CIS), developed by Keller (2010), was utilised to collect the data. The CIS consisted of 34 items measuring motivation in the domain of learning combined transformation through instruction. Sample was asked to indicate, on a five-point Likert-type scale, the degree to which each statement was personally true to them. The CIS assessed four aspects of motivation in learning: attention (8 items), relevance (9 items), confidence (8 items) and satisfaction (9 items). Table 3 shows the sample items for each dimension of CIS. The attention relates to capture the interest and curiosity of learners; the relevance relates to learner's feelings of attraction towards their goals; the confidence relates to learner's expectation for success; and the satisfaction relates to the learner's feeling of rewarding over their achievement. Keller (2010) provided evidence for both the internal consistency (reliability) with Cronbach's alpha values above 0.80 for each subscale, and situational validity with correlations at or beyond 0.05 level as well as the validation from the same mathematics teachers from section (a).

Table 3. Sample item for ARCS dimensions of CIS

Dimension	Sample Item
Attention	The teacher knows how to make us feel enthusiastic about the subject matter of this lesson.
Relevance	The things I am learning in this lesson will be useful to me.
Confidence	I feel confident that I do well in this lesson.
Satisfaction	I feel that this lesson gives me a lot of satisfaction.

Source: Adapted from Keller (2010)

Interview

Interviews were used to collect supplementary data. It contributed to greater participants' insight, meaning and understanding of their experiences. Six participants were chosen by using random purposive sampling (Gay, Mills, & Airasian, 2014) through Statistical Package for the Social Science (SPSS) based on the differences of CIS pre-test and post-test who also scored well in TGT. The interviews started with explaining the purpose and confidentiality of the interview, and seeking permission for audio recording. Then, the researcher asked questions within the scope of study, such as "Tell me about how the present lesson is different to previous lesson?" Next, member checking strategy was used to achieve the internal validity of the data transcriptions (Merriam, 2009). It involved each participant to provide their feedback and confirmation in the transcriptions.

Instructional Design (ID)

Dick and Carey model of instructional design was referred to in the development of the instructions (Dick, Carey, & Carey, 2009). First, analysis of discrepancies between instructional goal and the present state of learning were identified. According to the teacher, students found combined transformation topic hard to learn without the aid of an instructional tool. Thus, Geogebra was selected for this purpose because it provides visual aids and allows the student to make meaningful discoveries about the subject. Secondly, learning concepts were identified in the form of conceptual map (see Figure 3), followed by the students' characteristics in the aspects of academic motivation, prior knowledge of the topic and entry skills in using Geogebra. Thirdly, formative and summative tests were developed, corresponding to the learning objectives. Fourthly, student-centred approach was chosen as the choice of delivery system by incorporating the ARCS strategies. Next, the development of learning activities was done using Geogebra. Then, a pilot study was conducted on a group of Form Four students after the instructional activities had been evaluated by an experienced mathematics teacher. Lastly, the instructions were modified based on the suggestions provided by the teacher and obstacles faced during the pilot study.

Procedure

Permission to collect data from the school was received from the selected school administrator. Prior to the instruction using Geogebra, a pre-test of CIS and TGT was administered to the students to determine their initial motivation level and achievement on combined transformation. Students were assigned to sit in pairs according to the original seating arrangement. Each student used one computer for learning. Each lesson generally followed the following sequence: (a) introduction (5 minutes), self-explore instructional activities (20 minutes), (c) answer formative assessments (30 minutes), and (d) summarise the lesson (5 minutes). Table 4 shows the summary of the lessons. Next, the researcher carried out the instruction using Geogebra, which consisted of two double-period lessons (240 minutes). After instructions and formative tests using Geogebra, a post-test of CIS and TGT was administered to determine students' motivation level and geometric understanding on combined transformation after the intervention. Lastly, semi-structured interviews were conducted with six students to determine the influences of the instruction on students' motivation.

Table 4. Summary of the lessons

Lesson	Learning objective (refer Table 3.)	Activities/ Formative Assessment	ARCS component	ARCS Strategies (Keller, 1987)
1	To refresh single transformation concept and relate the students' experience in transformation	Activity 1, 2, 3(a)–3(d), 4(a)–4(b)	Attention, Relevance	Concreteness, Experience
2	a, b	Activity 5, 6. Formative 5(a)–5(b), 6(a)–6(b)	Confidence, Satisfaction	Learning requirements, natural consequences
3	c, d	Activity 7, 8. Formative 7(a)–7(b), 8(a)–8(b)	Confidence, Satisfaction	Learning requirements, natural consequences
4	e, f, g	Activity 9, 10, 11. Formative 9(a)–9(b), 10(a)–10(b), 11(a)–11(b)	Relevance, confidence, satisfaction	Choice, learning requirements, natural consequences

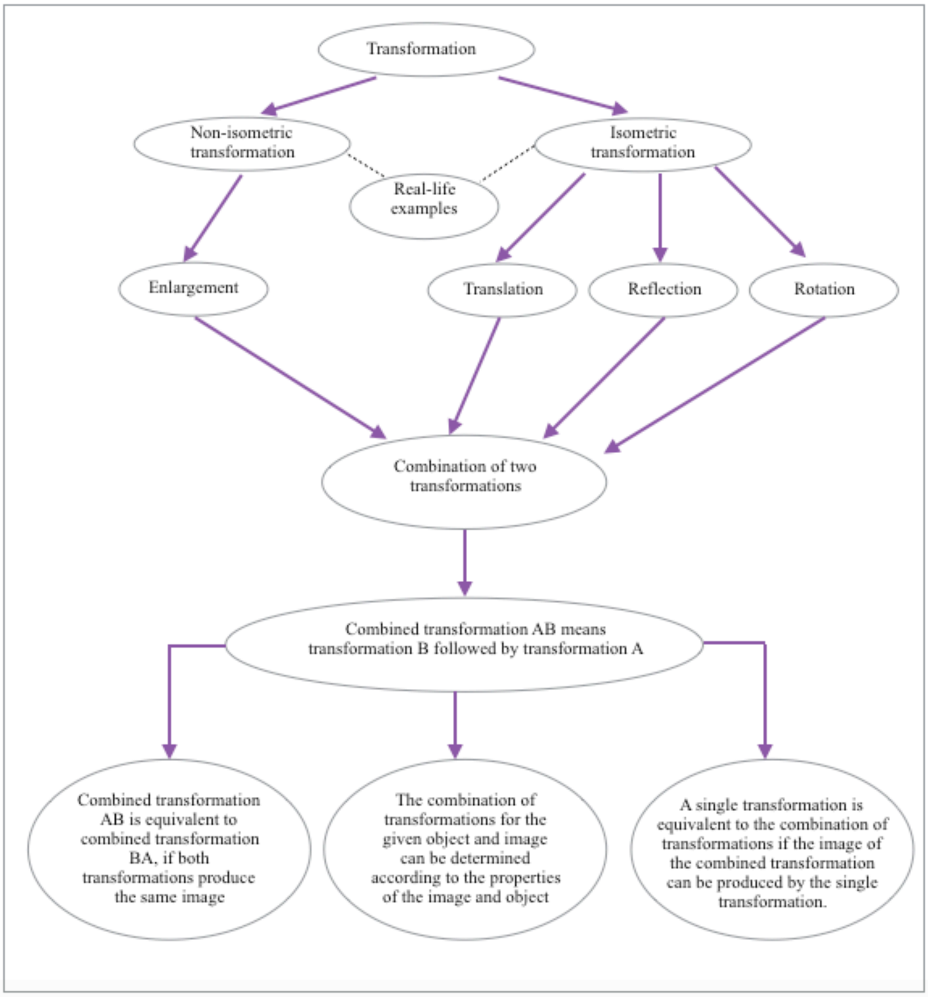

Figure 3. Conceptual Map

Data Analysis

A pilot study of the instructions and instruments was administered to 23 Form Four students at a secondary school. The aim of the pilot study was to investigate and test the design of the full-scale research study. There would be insights if any difficulties arose during the instructions, formative tests and instrument implementation. The instruments were then tested for reliability, which yielded coefficients of 0.882 for CIS while Keller (2010, p. 281) yielded coefficients of 0.95 and 0.747 for TGT, which complied with the suggested high reliability in educational research (Gay et al., 2014). Paired-sample t-test was utilised to examine the significant difference in the students' achievement through TGT, while Wilcoxon Signed-Rank test was utilised to examine the significant difference in the students' motivation due to the ordinal nature of CIS.

In addition, steps in analysing the interview data as described by Miles, Huberman and Saldana (2014) were applied in this study. First, interview protocols were presented in the form of conversation between the researcher and participants. Next, the researcher read through the transcripts to identify the segment to be coded, known as first cycle coding. Then, it was followed by the second cycle coding (pattern coding) to identify the themes and the condensed data were presented in a matrix display. Lastly, peer review and member check were applied to achieve validity and reliability of the data.

RESULTS

The results of the pre-test and post-test for TGT are presented in Table 5. It shows that there is a significant difference ($t = -10.025$, df = 23, $p < .05$), where the pre-test mean is 21.46 and post-test mean is 32.88. In other words, the intervention is able to increase students' achievement in combined transformation.

Table 5. Paired-sample *t*-test for TGT

Test	*N*	Mean	Std. Deviation	Std. Error Mean	*t*	df	*p*
Pre	24	21.46	5.703	1.164	–10.025	23	.000
Post	24	32.88	5.535	1.130			

On the other hand, the results of the pre-survey and post-survey for CIS are presented in Table 6. It shows that there is a significant difference ($Z = -4.287$, $p < .05$) with positive mean rank of 12.50 higher than negative mean rank 0.00. The median value of post-survey is higher than the median value of pre-survey as shown in Figure 4, indicating that the intervention had significantly enhanced the students' motivation.

Table 6. Wilcoxon test for CIS

		N	Mean Rank	Sum of Ranks	*Z*	Asymp.Sig (2-tailed)
PostCIS-	Negative Ranks	0[a]	.00	.00	–4.287[d]	.000
PreCIS	Positive Ranks	24[b]	12.50	300.00		
	Ties	0[c]				
	Total	24				

Notes: [a] PostCIS < PreCIS; [b] PostCIS > PreCIS; [c] PostCIS = PreCIS; [d] Based on negative ranks

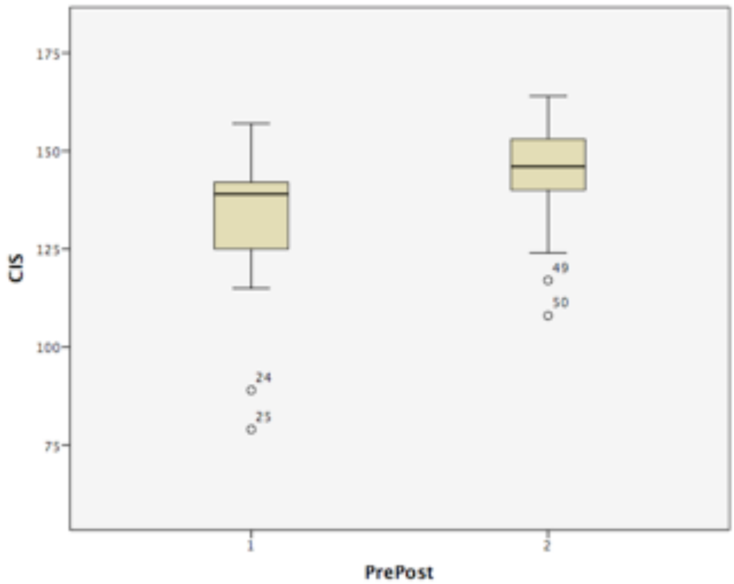

Figure 4. Boxplot for pre-survey and post-survey CIS

To answer the third research question, the findings are mainly based on the analysis of the interview transcripts by using Atlas.ti. Besides probing for participant's motivation in the aspects of ARCS and the differences of the learning experiences after the intervention, they were probed for influences in learning mathematics for future undertakings. Three themes emerged after interview with the participants: learning experience, learning enhancement and interactive learning.

Learning Experience

Interviews with participants indicated that teacher-centred lesson was commonly adopted in mathematics class. Thus, participants appeared to play a fairly passive role. Conversely, the intervention allowed them to play an active role.

> I think it is a better method in teaching because it gets the students more active in the class and it's not just looking at the board… You got to try out the examples and you understand more. (Participant 3, text-unit 17)

Another participant commented that self-exploring learning provided an "adventurous" environment, as in the following example:

> You can play and you can explore… You can explore on your own, as an adventurous as I said before, adventure for you, adventure to learn maths. (Participant 1, text-unit 52)

It can be seen that the participants preferred the new learning experience compared to the teacher-centred approach.

Learning Enhancement

Interviews with participants revealed that motivation is important in learning mathematics, specifically combined transformation. To a participant who claimed to have high motivation, she commented that "I always set a goal for myself and maths being something I always like…., and that in itself being motivation itself for me to strive for the better." (Participant 2, text-unit 12). In contrast, a participant who claimed to have low motivation commented, "I am not a person who is gifted in mathematics and I don't enjoy calculation subject…, I believe motivation is very, very important." (Participant 4, text-unit 08).

Nevertheless, the intervention increased the participants' motivation in different ways.

> If you get it right, then you feel satisfied, then you keep on working to get the correct answer and it's quite motivating. (Participant 5, text-unit 49)

> If I do something right, there is a little check mark. You know it is correct and because you see all these motivational little ticks, so you will see that you can do this. It is a kind of motivation to further study mathematics. (Participant 3, text-unit 65)

Consequently, the motivation influenced their achievement, as in the following example:

> Getting much better understanding of the chapter, I have more confidence in answering the questions. (Participant 6, text-unit 126)

Apparently, the intervention motivated the participants to study this topic and improve their grade.

Interactive Learning

Interviews suggested that student-centred approach encouraged interactive among the lessons, students and Geogebra.

> We were given much more interactivity because we have the opportunity to work on the computer… I got to learn more for my friends and actually help them to solve the questions and teach them how to do it. (Participant 6, text-unit 25)

> It is a unique experience that the fact that the software is very interactive gives me a lot of abilities to see what I couldn't see on paper. (Participant 4, text-unit 39)

> I think all these little pictures you've created in Geogebra like you have Bart Simpson stuff and because it is more our generation. (Participant 3, text-unit 27)

The present study has highlighted the importance of integrating motivation strategies into the instruction and influences the students in learning.

DISCUSSION AND CONCLUSION

The result of the paired-sample t-test showed that there was a significant difference in the students' achievement, indicating that the intervention had significantly improved students' achievement in combined transformation. In addition, the result of Wilcoxon test showed that there was a significant difference in students' motivation. The median of CIS in the post-survey was higher than pre-survey, indicating that the intervention had significantly enhanced students' motivation.

On the other hand, the findings of the interviews indicated the influences of the intervention on the learning experiences and motivation. The participants preferred the self-exploring approach prepared in this study because it was "enjoyable" and "exciting" compared to teacher-centred approach. This new learning approach enabled them to have better interaction with their friends, teacher and technology (Shadaan & Leong, 2013). Also, their attention and interest were captured by the instructional activities because it was something new and no other teachers had done this before. Consequently, they were confident in answering the questions because Geogebra allowed them to "visualise" the shapes (Bakar, Ayub, & Tarmizi, 2010).

The results obtained from this study were consistent with the results of previous studies on instruction incorporated with ARCS strategies (Main, 1992). Furthermore, the result of using Geogebra improved students' motivation and understanding in concurrence with the findings of Kamariah, Ahmad, Wong and Rohaini (2010), and Shadaan and Leong (2013).
The contribution of the present study is the implication of the need to incorporate the motivation aspect into instruction. As reviewed by the participants, they preferred self-explore teaching and learning approach because they were able to visualise the combined transformation of an object and helped them to answer the questions in the examinations. This information would be useful in developing instructional activities for combined transformation by the teachers.

Nevertheless, the limitations of this study need to be considered. The results from this study could not be generalised to other settings because this study was carried out in one particular school with the sample comprising of 24 students only. Thus, other directions for future research are warranted. The present study should be replicated in other larger population samples, such as lower secondary and primary students.

In conclusion, the findings of this study suggested that instructions incorporated with ARCS theory using Geogebra had significantly enhanced students' achievement about combined transformation and motivation. This implies that with well-designed instructional activities and the teachers as facilitators, students can learn geometric topics in a fun and enjoyable environment. In fact, this will influence their motivation in learning mathematics.

REFERENCES

Bakar, K. A., Ayub, A. F. M., & Tarmizi, R. A. (2010). Exploring the effectiveness of using Geogebra and e-transformation in teaching and learning mathematics. *Proceeding of the 6th WSEAS/IASME International Conference on Educational Technology (EDUT' 10)* (pp. 19–23), Tunisia.

Battista, M. T. (1994). Teacher beliefs and the reform movement on mathematics education. *The Phi Delta Kappan*, *75*(6), 462–470.

Chew, C. M. (2007). *Form one student's learning of solid geometry in a phase-based instructional environment using geometer's sketchpad.* Unpublished doctoral dissertation, University of Malaya.

Choi-koh, S. S. (2000). The activities based on van hiele model using computer as a tool. *Journal of the Korea Society of Mathematical Education Series D: Research in Mathematical Education*, *4*(2), 63–67.

Dick, W., Carey, L., & Carey, J. O. (2009). *The systematic design of instruction* (7th ed.). Upper Saddle River, NJ: Merrill.

Effandi, Z., & Zanaton, I. (2007). Promoting cooperative learning on science and mathematics education: A Malaysian perspective. *Eurasia Journal of Mathematics, Science & Technology Education*, *3*(1), 35–39.

Fuys, D., Geddes, D., & Tischler, R. (1988). The van Hiele model of thinking in geometry among adolescents. *Journal for Research in Mathematics Education Monograph Number 3.* Reston, VA: National Council of Teachers of Mathematics.

Gay, L. R., Mills, G. E., & Airasian, P. (2014). *Educational research: Competencies for analysis and applications* (10th ed.). Essex, England: Pearson Education Limited.

Hong, L. T. (2005). *Van Hiele level and achievement in writing proofs among form six students.* Unpublished Master thesis, University of Malaya.

Kamariah, A. B., Ahmad, F. M. A., Wong, S. L., & Rohaini, A. T. (2010). Exploring secondary school students' motivation using technologies in teaching and learning mathematics. *Procedia Social and Behavioral Sciences*, *January*, 4650–4654.

Keller, J. M. (1987). Strategies for stimulating the motivation to learn. *Performance and Instruction Journal, October*, 1–7.

Keller, J. M. (2010). *Motivation design for learning and performance: The ARCS model approach.* New York, NY: Springer.

Koo, A. C., Teoh, S. H., Ahmad, R. M. E., & Khairul, A.S. (2009). *Pedagogical guide for geometry education*. Proceeding of the 3rd International Conference on Science and Mathematics Education, 10–12 Nov 2009, Penang, Malaysia, 329–335.

Lim, C. S. (2001). Teacher's influence on adult's images of mathematics: Implication for mathematics teacher education. *Jurnal Pendidik dan Pendidikan, 17*, 57–67.

Main, R. G. (1992). *Integrating the affective domain into the instructional design process.* California State University, College of Communications. Brooks AFB, TX: Air Force Systems Command.

Malaysian Ministry of Education (2011). *Kurikulum standard sekolah rendah: Matematik (tahun satu).* Kuala Lumpur: Curriculum Development Centre.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco, CA: Jossey-Bass.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Washington, DC: Sage.

Mullis, V. S., Martin, M. O., Foy, P., & Arora, A. (2012). *TIMSS 2011 international results in mathematics.* Boston: International Study Center.

National Council of Supervisors of Mathematics. (1989). Essential mathematics for the twenty-first century: the position of the national council of supervisors of

mathematics. *Arithmetics Teacher, 37*(1), 44–46.
National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston: VA.
Patel, T. (2014). Dropping out of school in Malaysia: What we know and what needs to be done. Policy Ideas No.14, Institute for Democracy and Economic Affairs.
Schunk, D. H., & Pintrich, P. R. (1996). *Motivation in education: Theory, research, and applications*. NJ: Prentice-Hall.
Shadaan, P., & Leong, K. E. (2013). Effectiveness of using Geogebra on students' understanding in learning circles. *The Malaysian Online Journal of Educational Technology, 1*(4), 1–11.
Snow, R. E., Corno, L., & Jackson, D., III (1996). Individual differences in affective and conative function. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 243–510). New York: Simon and Schuster Macmillan.
Tahta, D. (1990). Is there a geometric imperative? *Mathematic Teaching*, *129*, 20–29.
Van Hiele-Geldof, D. (1957/1984). The didactics of geometry in the lowest class of secondary school. In D, Fuys, D. Geddes & R. Tischler (Eds.), *English translation of selected writings of Dina van Hiele-Geldof and Pierre M. van Hiele* (pp. 1–214). Brooklyn: Brooklyn College.
Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.