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The Activities Based on Van Hiele's Phase-Based Learning: Experts' and Preservice Teachers' Views

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Abstract: The effective learning strategies for mathematics topics may vary according to the topic. For geometry, the activities that are suggested to be implemented are carried out using Van Hiele's phases of learning geometry. The phases include Information, Guided Orientation, Explicitation, Free Orientation and Integration. The implementation of these phased-based activities is easier and more effective with the presence of dynamic geometry software, especially the Geometer's Sketchpad (GSP). Therefore, the purpose of this article is to discuss the activities based on Van Hiele's phases of learning geometry, using the GSP computer software as a tool. The developed activities were given to eight experts to get their views on the activities. Besides that, 24 pre-services teachers were also given the activities for the purpose of investigation of paedagogical usability of the developed activities. The results showed that the developed activities were well-arranged based on Van Hiele's phases of learning geometry with the assistance of GSP. The results also showed that the developed activities met the requirements of the pedagogical usability criteria. Since these phase-based activities obtained positive views from experts and pre-services teachers, the activities can be carried out in teaching and learning geometry.

Key words: Van Hiele's phases of learning geometry, Geometer's Sketchpad (Gsp), pedagogical usability criteria

INTRODUCTION

Geometry is an important branch of mathematics and it is well known to be one of the basic skills to be mastered (Hoffer and Hoffer, 1992; Hong, 2005; NCTM, 2000). The importance of geometry cannot be over estimated in human life. Thus, the topics of geometry in Malaysian education system are formally taught as early as the primary school, when the students are exposed to the concepts of geometry in the topic of "The Two Dimensions and Three Dimensions" (MOE, 2004). Introduction to the geometry is increasingly emphasised in the curriculum when students enter secondary school. This is due to the fact that 40% of the 60 topics contained in the Integrated Curriculum for Secondary School Mathematics (KBSM) from Form One to Form Five are geometry topics (MOE, 2004). Because of the importance of geometry in the daily life of students and the emphasis on the topic of geometry in the mathematics curriculum, the process of teaching and learning geometry should be made more meaningful with the implementation of effective learning strategies. The effective process of teaching and learning geometry is not the same as the process of teaching and learning other mathematics topics such as arithmetic, algebra and probability (Noraini, 2005). The process of teaching and learning geometry should emphasise hands-on exploration, creative thinking and the ability to argue, generate conjectures and implement projects about geometry. The content of geometry topics can be systematically structured based on van Hiele's phases of learning geometry. These phases include information, guided orientation, explicitation, free orientation and integration. These learning activities are more easily implemented with the presence of various technologies. NCTM stresses the importance of using technology in teaching and learning mathematics by making it as one of the six principles of the teaching and learning of Mathematics (NCTM, 2000). Curriculum Development Centre of Malaysia in the Mathematics syllabus (MOE, 2004) also has explained the use of appropriate and effective technologies to help

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students to improve their skills and to achieve the required learning outcomes. Dynamic geometry software is the most effective tool in the process of teaching and learning geometry. The dynamic geometry software that has many advantages when compared to others is the Geometer's Sketchpad (GSP).

There are several attributes of dynamic geometry software that can help students to learn geometry more meaningfully. One of these attributes is the ability to specify the geometrical relationships among objects created on the computer screen, such as points, lines and circles. Another attribute is its ability to explore graphically the implications of the geometrical relationships established when constructing a figure. Within the computer environment, the geometrical objects created on the screen can be manipulated, moved and reshaped interactively with the use of the mouse (Christou *et al*., 2005). In addition, the tools, definitions, exploration techniques and visual representations associated with dynamic geometry contribute to a learning environment that is fundamentally removed from its straightedge-and-compass counterpart (Laborde, 1998). In this new millennium era, a great deal of dynamic geometry software is being introduced. One of them is the Geometer's Sketchpad (GSP), which is operated by Key Curriculum Press (Jackiw, 1991). MOE has obtained a license to use the GSP in teaching and learning. MOE has signed an agreement with Key Curriculum Press, so that the GSP can be used by teachers, lecturers and students in schools, colleges and universities throughout the country (Norhana, 2008). In the secondary school mathematics curriculum, specification for Form One to Form Five, a total of 29.51% or equivalent to 18 topics (mostly are geometry topics), are proposed to be taught using the GSP (MOE, 2004).

The Geometer's Sketchpad (GSP) is dynamic, interactive and user-friendly software that was first used in mathematics education nearly ten years ago. This software was designed by Jackiw (1991) is a tool to allow students to draw and see the movements, changes in position and shapes of the object through exploration. According to Gan and Chen (2006), its dynamic nature allows students to investigate mathematical relationships and make accurate conclusions or conjectures from the patterns formed. The GSP also facilitates users in drawing any geometry figures such as triangles, circles, straight lines, block and a variety of shapes in three dimensions. The software can also help students to solve problems in algebra, trigonometry and calculus. It can be applied in teaching and learning translation, reflection, rotation and enlargement and other mathematical functions. In addition, it can be used to make calculations and measurements quickly and accurately. The GSP was awarded the Best Educational Software of All Time, Most Valuable Software for Students, Best Education Program, Parent's Choice Group Approval Winner and Instructional Software Readers' Choice Award (Gan and Chen, 2006).

Many researchers have studied the process of thinking and learning in the field of geometry. They include Jean (1981) who introduced the three levels of geometric thinking used to describe geometric concepts for children from kindergarten to adulthood. Over the years, the mathematicians have continued to do research on the geometric thinking, but no one has managed to attract as much attention as to the model for geometric thinking levels proposed by Hiele (1986). Van Hiele Model has been the subject of ongoing academic research in the field of geometry and has been applied to various areas of geometric study (Bruni and Seidenstein, 1990; Battista, 2002; Walle, 1994; Noraini, 2005; Halat, 2008). Many researchers have recognised the value of the geometric thinking implemented by the van Hiele Model (Fuys and Liebov, 1997; Usiskin, 1982). Also has noted that the thoughts of the students in two-dimensional geometry are best explained by using van Hiele's model for geometric thinking.

Van Hiele's model was developed by Pierre van Hiele and Dina van Hiele-Geldof at the University of Utrecht in the Netherlands. It consists of five stages labelled 1 to 5. The five levels of thinking are hierarchical in order. The transitions from one level to another are dependent on the student's experience rather than his or her chronological age. Crowley (1987) describes some of the features of van Hiele model as follows:

- Students must go through the stages in the model sequence
- Students must move through the stages without omitting any levels
- The instructions must be given at each level to ensure that learning occurs. If the instructions given at a higher level that the students' ability, they will have difficulty in following the thought processes

The first level in the model is visualisation. At this stage, students can identify geometric shapes and they can recognise and identify geometry shapes based on the entire entity (Halat, 2008). According to Noraini (2005), geometric entities are considered as a whole and are not made up of components or attributes. In other words, students do not identify the geometric properties from a list of shapes. The second level in the model is analysis. At this stage, students are able to identify the properties of a shape. For example, a square is quadrilateral with two pairs of parallel opposite sides and all the sides of a square are equal in length (Mayberry, 1983). The third level is formal deduction. At this level, students can see the relationships among shapes and state the relationships among them. This is then followed by simple verification, a process that not all students understand. They can however relate the relationships to existing knowledge and developed arguments to establish correct generalisations. The fourth level in the model is deduction. Students at this level comprehend the meaning and importance of deduction and the role of postulates, theorems and proofs. They are able to prove through their own understanding. They also understand that the verification process can be carried out in more than one way. The fifth level in the van Hiele model is rigor. At this stage, students understand how to work within the axiomatic system. They are able to make abstract deductions.

Noraini (2005) has explained that the progression from one stage to the next depends on the learning methods and content of the topic rather than the maturity of a student. Thus, the content of particular geometry topic should be well-planned, so that it can encourage the active involvement of students in the learning geometry. The transitions from one stage to the next are not natural processes as they are greatly influenced by the teaching methods employed (Craft, 2000). To provide geometry learning experiences that can help students advance through the levels of van Hiele Model, van Hiele has suggested five phases of activities in the process of learning; Information, Guided Orientation, Explicitation, Free Orientation and Integration (Halat, 2008).

Teppo (1991) provides several examples of student activities to demonstrate the implementation of Van Hiele's phases of learning geometry model. The movement of students from one level to a higher level is the result of meaningful learning activities that are organized into five phases which focus on the nature of exploration activities, discussion and integration. According to her, a student's level of geometrical thinking can be improved through various learning sessions. During each learning session, students are associated with an object and become actively involved in the activities provided. This enables them to move from one level of thinking to a higher level. Choi-Koh (2000) has developed activities based on Van Hiele's phases of learning geometry by using the GSP. According to them, the most challenging stage faced by teachers in teaching geometry is the development of materials and teaching aids that help students improve their understanding of geometric concepts. Traditional text books only focus on the skills of students in arguing deductively. Students simply memorise without understanding the theory and evidence of geometric concepts. One hypothesis in the Van Hiele Model is that when students are given a concept that is at the level of mental development that exceeds the level of their ability, they will accept the concept in a variety of ways. There are students who only accept it without understanding it and tend only to memorise it. There are also students who give up and ignore it because they do not understand what is being taught. This clearly shows that teachers need to provide their students with appropriate learning experiences so that the transfer of understanding of geometric concepts can occur naturally and meaningfully. Therefore, it is important for teachers to know the students' geometrical thinking and develop activities based on the Van Hiele Model. In this context, has developed phase-based activities for the two sessions. The first learning session is aimed at helping students improve their level of geometric thinking from level 1 to level 2, while the second session helps the students improve their level of geometric thinking from level 2 to level 3. The activities have been developed based on Van Hiele's phases of learning geometry, which are Information, Guided Orientation, Explicitation, Free Orientation and Integration. These activities are undertaken by students with the help of the GSP and the topics covered the types of triangles.

Serow (2008) has implemented a project using the phases and included elements of technology to foster teaching and learning geometry in mathematics classes. Her research used a pre-experimental design with a group of 23 students from Year 9 and they were assessed via pre- and post-tests. The contents of the teaching materials were designed in two forms, which were phases of teaching as a framework and the integration of dynamic geometry software with Microsoft Excel and concept-mapping software. The study lasted for two consecutive weeks, with a total of 8 sessions with each session lasting 40 min. The topic of this study was the geometry of space and the subtopics involved were "the construction and identification of the properties of triangles and quadrilaterals" and "the proof of the quadrilaterals". The sessions also included assignments aimed at helping students use the more formal level of language. The study found that Van Hiele's phases of learning geometry are an effective framework in organising activities using dynamic geometry software. Students remained actively involved in doing the tasks and also interacted with one another. These situations elevated the students' use of language from informal to formal. The integration of other software caused the dynamic geometry software to be more effective. In this context, has concluded that experimental and exploratory strategies, when integrated with dynamic geometry software, are able to enhance the understanding of students of geometric concepts. In addition, the phases of learning and the use of technology are important in attracting students to study geometry.

Meng (2009) has investigated Form One students who learned solid geometry in a phase-based instructional environment using a GSP based on the Van Hiele Model. Specifically, he examined the students' initial Van Hiele levels of geometric thinking on cubes and cuboids and how their Van Hiele levels were altered by phase-based instruction with GSP. He used a case study design and purposive sampling to select six students with different abilities from a Form One class. His research involved three sessions in which, during the first session, the researchers conducted interviews with each sample to determine the initial level of the students' geometrical understanding of cubes and cuboids. In the second session, the students were taught the properties of cubes and cuboids through Van Hiele's learning phases by using GSP, with a total of 14 activities provided. In the third session, he conducted interviews to determine the level of the students' geometric thinking after being exposed to Van Hiele's learning phases using GSP. His findings revealed that the participants' initial Van Hiele levels ranged from Level 0 to Level 2. After phase-based instruction with GSP, their Van Hiele levels either increased or remained the same.

MATERIALS AND METHODS

Based on the discussion on the importance of geometry in students' daily life and on the emphasis placed on geometry topics in the secondary school's Mathematics syllabus as well as the advantages found in Geometer's Sketchpad (GSP) software, the researchers planned to develop activities to make the process of teaching and learning geometry more effective. Based on the literature review, Van Hiele's Model has proposed activities for geometry topics that are arranged and then implemented based on Van Hiele's phases of learning geometry. Therefore, the researchers have developed activities for form two students based on the phases for the topic Quadrilaterals: Their Properties and Relationship. As shown in Fig. 1 students must go through the information, guided orientation, explicitation, free orientation and integration phases to advance from the first level to the second level of geometric thinking and they have had to go through the same phases to advance to the next level. In this study, activities were prepared to assist students to enhance to the third level of geometric thinking. This is due to the fact that many previous research revealed that lower secondary school students usually can only reach up to the third level of geometric thinking which is informal deduction (Usiskin, 1982; Walle, 1994).

In the first learning session, learning activities are provided to help students advance from the first level of the Van Hiele Model; visualisation, to the second level; analysis. Students will go through all phases; visualization, guided orientation, explicitation, free orientation and integration to move from the first level to the second level. The objective of the activities is to help students identify quadrilaterals and to understand their properties. For example, students will come to know that a parallelogram has equal and parallel opposite sides, equal opposite angles and its diagonals bisect each other. In Phase 1 which is information, students will become acquainted with the activity. Teachers will present a new idea and allow students to begin working on the concept. In the example given by Idris (2007), shapes such as rhombus are introduced in this phase. Students are then introduced to other geometrical shapes and asked if the shapes are rhombus. In the study by Husnaeni (2006), teachers gave a few figures of various shapes and asked the students to identify triangles and other shapes. A similar study by Choi-Koh (2000) stated that in information phase, students were able to recognize and draw the shapes. They could identify the type of triangle, be it equilateral triangle, isosceles triangle, or right triangle. In the study by Liu (2005), in the topic of Circles, students used their own description to name the sides in a circle in the information phase. They most probably named the sides based on their external properties.

In this research, as shown in Fig. 2, the available activities will help students to develop and recognise the variety of the quadrilaterals. For example, students can recognise that (a) rectangle, (b) square, (c) parallelogram, (d) rhombus and (e) kite.

By using the GSP, the students will then be able to construct quadrilaterals and then identify the properties they possess.

In Phase 2 which is guided orientation, students are given activities that allow them to become familiar with the many properties of the new geometric concept. They will carefully explore the objects used in the instruction. In this phase, students explore the properties of rhombus by folding a rhombus at its axial symmetry and by observing the diagonals and sides (Idris, 2007). Meanwhile, in this phase for triangles, Husnaeni (2006) stated that students in groups were asked to observe figures of triangles and non-triangles. They were then asked to classify the figures into triangles and non-triangles. After that, they were asked to cut figures of triangles and draw the figures again in various sizes. The purpose of this activity is to help students explore the properties of the various types of triangles. In the study by Choi-Koh (2000), students used the GSP software to explore the properties of equilateral triangle, isosceles triangle and right triangle. In the study by Liu (2005) in the topic of Circles, students were asked to measure the angles and state the relationship between the two angles.

In this research, the activities will give students an opportunity to explore the properties possessed by any quadrilaterals by using the GSP. The processes of constructing quadrilaterals and exploring their properties can be done easily and effectively because the dragging capability of the GSP allows students to manipulate and reshape the geometrical objects with the use of the mouse. Without the use of any dynamic geometry software, students may find difficulties in constructing the shapes and getting the right values for their widths, lengths and angles. This is due to the weaknesses in construction and exploration when using paper, pencil and compass.

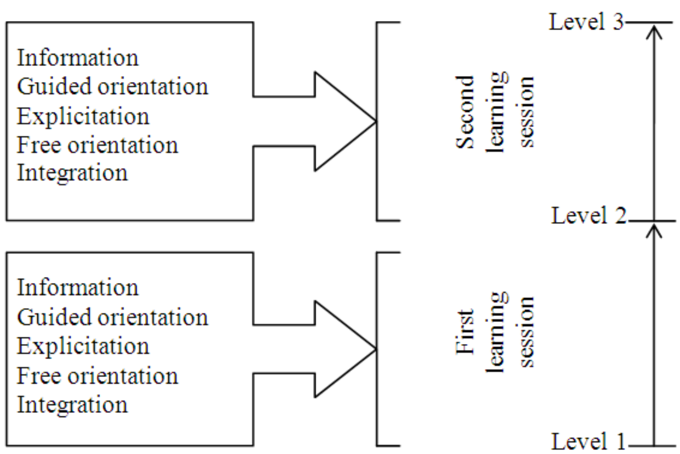

Fig. 1: The Van Hiele's phases of the learning geometry

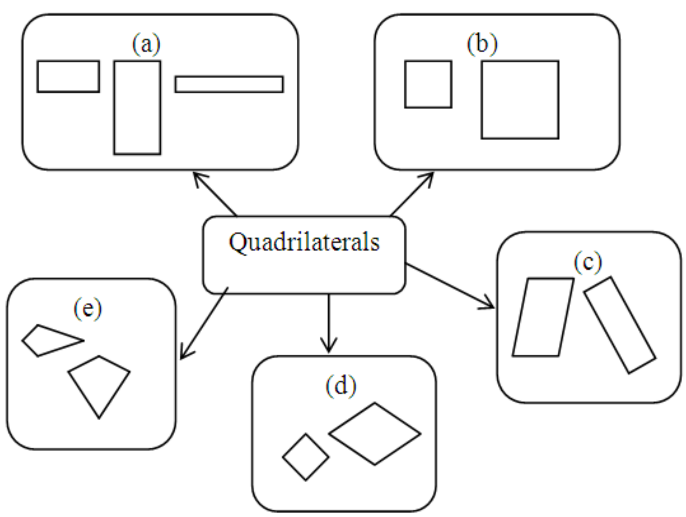

Fig. 2: Types of quadrilaterals

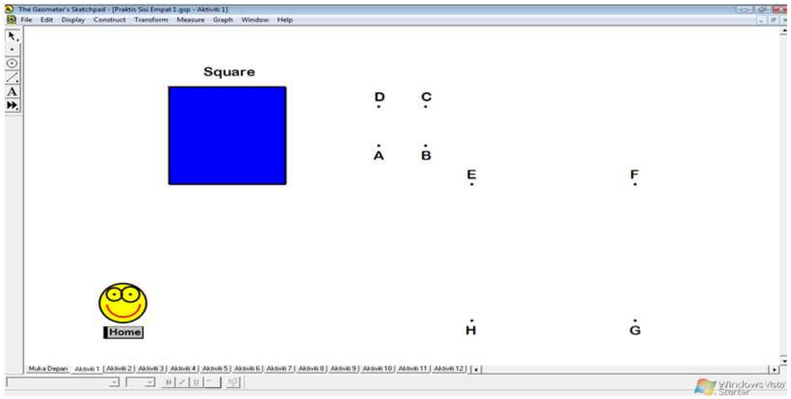

Fig. 3: Students create a square by using the GSP in the first phase

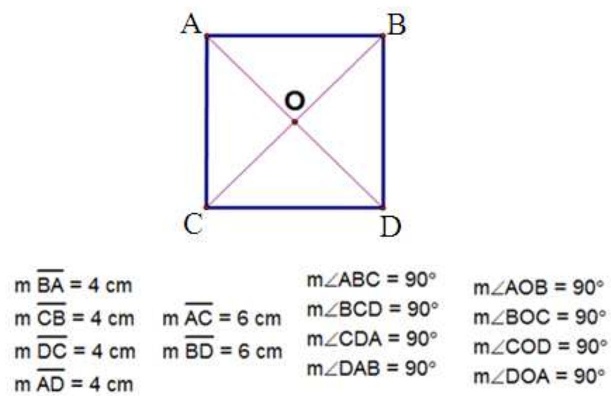

Fig. 4: In the second phase, students investigate the properties of a square by using GSP

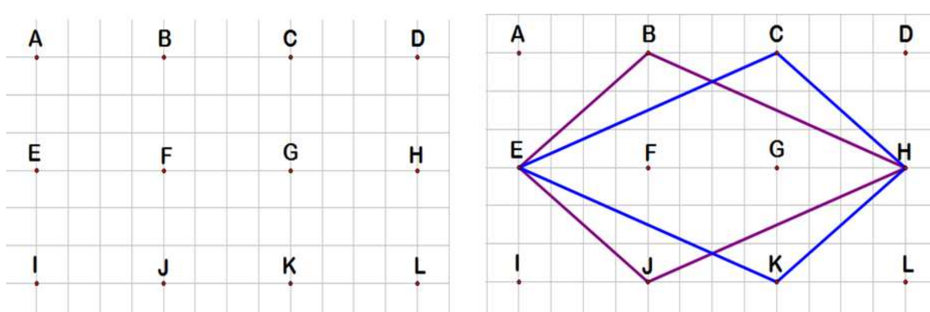

Fig. 5: In the fourth phase, students connect the assigned dots to produce kites

For example, as shown in the Fig. 3, when students are asked to explore the properties possessed by a square, the data obtained (as shown in Fig. 4) will be filled into the table for the purpose of discussion in the next phase.

In explicitation phase, students express in their own words what they have discovered in the previous phase. The role of the teacher here is to introduce relevant geometrical terms. In this phase, students exchange their opinions about the properties of rhombus (Idris, 2007). In the topic of Triangles, students explain their experience with their classmates and teachers on the properties of each type of triangle by using their own words (Husnaeni, 2006; Choi-Koh, 2000). In the topic of Circles, students discuss the relationship of the angles that they have explored in front of the class. Teachers then introduce the exact terminologies to the students (Liu, 2005). In this research, students will explain their observations from the activities carried out earlier. With reference to the data derived from exploration using GSP, students can now explain the properties possessed by a square, rectangle, parallelogram, rhombus and kite.

In Phase 4 which is free orientation, students will carry out more complex tasks; tasks that are more open-ended than in the guided orientation phase. The problems may be more complex and require more free exploration to find solutions. In this phase, a few edges and sides of rhombus are given in various positions and students are asked to build the whole figure of a rhombus (Idris, 2007). In the free orientation phase in the study by Choi-Koh (2000), students were given a triangle with two sides. They were then asked to put another side to make equilateral triangle, isosceles triangle, or right triangle. In this research, as shown in Fig. 5, students are asked to connect the assigned dots to produce specified quadrilaterals. They can build a particular shape correctly if they understand the properties possessed by quadrilaterals. For example, the diagram on the right shows kites constructed by connecting the points.

In the final phase; integration, students summarise and integrate what they have learned and develop a new network of objects and relations. This might be achieved in the form of discussions or an assignment. In the example given by Idris (2007), students summarise the properties of a rhombus in this phase. In the topic of Triangles, students summarise the various properties of triangles besides being able to differentiate the types of triangles based on their properties (Husnaeni, 2006; Choi-Koh, 2000). In this research, the teacher will help students to summarise the concepts that they have explored and come to understand in this learning session. The students will be able to describe the properties possessed by the forms of the four sides of a square, rectangle, parallelogram, rhombus and kite.

The objective of second learning session is to assist students in increasing their geometric thinking from level 2 to level 3. Therefore, as shown in Fig. 6 the activities in this session will be designed to help students strengthen their understanding on the properties of quadrilaterals and the relationships among them. Students will be able to verify these relationships by using non-formal deduction. In this learning session, students will again go through the phases in order to assist their movement from level 2; analysis to level 3; informal deduction.

In phase 1; information, students will reflect on the properties possessed by the quadrilaterals that they have produced in the previous session. They will now be asked to build quadrilaterals using the GSP. In guided orientation phase, the purpose of the activities is to help students identify the relationships among the quadrilaterals. Firstly, notes concerning the properties of quadrilaterals are provided in the GSP and students will come to understand their properties in detail by clicking on the buttons provided. After analyzing the quadrilaterals, they will then be asked to classify the quadrilaterals in terms of sides, angles and diagonals in the table. According to the data in the table, they are then asked to establish relationships among the quadrilaterals. Students and teachers will then discuss why a particular quadrilateral is distinct from other quadrilaterals in the explicitation phase. In phase 4 which is free orientation, students are given a particular quadrilateral (for example, a rectangle). They are asked to find the value of its properties. They are then asked to determine, by dragging any vertices of the rectangle by using the GSP, why another quadrilateral (for example, a square) is a special case of the original quadrilateral (a rectangle). Next, they are asked to find the common properties possessed by these quadrilaterals. Finally, upon completion of the second learning session, in the integration phase, students will be able to summarise all the relationships among quadrilaterals. They can understand and will be able to distinguish the quadrilaterals by their definitions and classification.

The developed activities were then given to ten experts consisting of content experts, technical experts and linguistics experts. The content experts were referred to verify that the developed activities were in accordance to Van Hiele’s phases of learning geometry, namely Information, Guided Orientation, Explicitation, Free Orientation and Integration. They were also referred to verify that the developed activities were suitable with the contents and the learning strategies utilized, as well as the implementation of the GSP software. The content experts included mathematics education professors and mathematics expert teachers. Next, technical experts were referred to to verify that the activities in the GSP software environment that were developed and organised into CD-ROM were easily accessible and utilised by students. They included multimedia education lecturers and information technology expert teachers. Next, linguistics experts were referred to verify the accuracy in terms of use of language. They included Malay language excellent teachers. The instrument utilised for getting views from the content experts was developed by the researchers on their own in making sure that the activities were suitable with Van Hiele’s phases of learning geometry. The instrument to be filled up by the technical experts was modified from the study by Rahman (2005), while the instrument to be filled up by the linguistics experts was modified from the study by Bakar (2003).

Besides the content experts, technical experts and linguistics experts, the researchers also collected views regarding the paedagogical aspect from trainee teachers. The trainee teachers were 24 final year students from the mathematics education programme in a local university. These activities that are based on Van Hiele's phases of learning geometry are newly implemented in Malaysia. Therefore, in line with the national education transformation that aims to emphasise thinking skills in the teaching and learning process, the trainee teachers must have adopted transformation in their teaching and learning approach in order to stimulate students' thinking skills. The instrument was adopted from the study done by Nordin *et al*. (2010), which was adapted from the study done by Nokelainen (2006).

RESULTS AND DISCUSSION

Based on the comments listed in Table 1 above, it can be seen that all constructs have high mean values. Moreover, the comments given are also encouraging. Besides that, the researchers also collected expert views from a professor in the field of mathematics education from Dankook University, who is greatly involved in developing and studying the effectiveness of the activities that are based on Van Hiele's phases of learning geometry. Among the responses obtained were that there were some spelling errors in naming the phases, there were some items that had to be inserted in the teaching activities and not to mention her opinion that the developed activities were actually interesting.

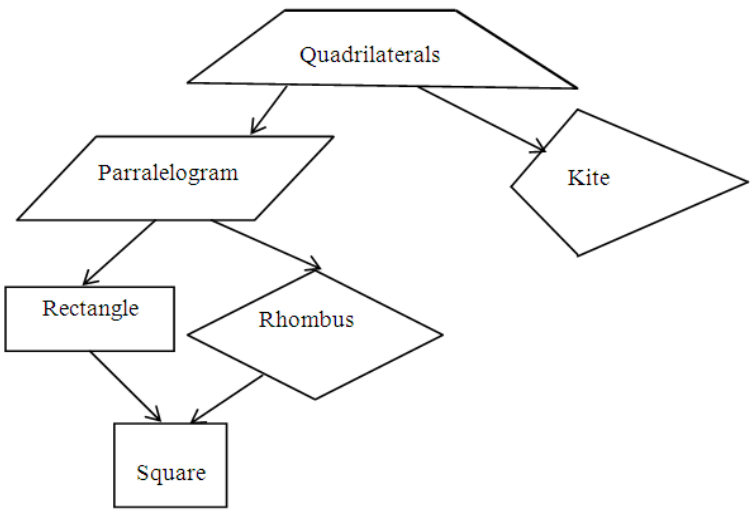

Fig. 6: The relationships among the quadrilaterals

Table 1: Views of content experts

Contruct	Mean (n = 4)	Comment
Contents in activities	4.56	This kind of approach should be
The use of Geometer's Sketchpad (GSP) software	4.88	applied formally in teaching and learning.
Generating conjecture learning strategy	4.95	The constructivist elements in understanding the concept are really
Van Hiele's Phase 1- Information	4.94	obvious and the hands-on method is really meaningful.
Van Hiele's Phase 2-Guided Orientation	4.88	A very good effort in developing students' thinking in geometry topics.
Van Hiele's Phase 3 - Explicitation	4.63	The activities can be utilised in school as they cover the school syllabus.
Van Hiele's Phase 4 -Free Orientation	4.58	The teaching and learning process becomes more effective and structured.
Van Hiele's Phase 5 - Integration	4.75	Students become more interested and they are free to finish the the assignments openly and creatively.

Table 2: Views of linguistic experts

Item	Percentage Given by Experts (n = 2) Yes (%)	No (%)	Comment
The format of the study is suitable and interesting	100		Arranged with language that is clear
The meaning of each item is clear	100		and easy to be understood
The language used is easy to be understood	100		
The size of the fonts is suitable and easy to be read	100		There are just a few spelling errors
The instructions given are clear	100		An effective innovation for
The font spacing is suitable	100		teaching and learning
The indicators for measurement scale are clear	100		purpose
There are no spelling errors	50	50	A good module for students'
The objectives stated are clear	100		teaching and learning process

Table 3: Results of usability criteria

Item	1 Strongly disagree n	(%)	2 Disagree n	(%)	3 Quite disagree n	(%)	4 Agree n	(%)	5 Strongly agree n	(%)	Mean
Activities could be applied in the teaching of mathematics.							15	62.5	9	37.5	4.38
Learning goals are clearly stated in the activities.					2	8.3	11	45.8	11	45.8	4.38
Activities do Integrate ICT in the teaching of mathematics							9	37.5	15	62.5	4.63
Activities using Geometer's Sketchpad in Mathematics lesson are appropriate.							16	66.7	8	33.3	4.33
Application of the activities makes learning more interesting.							12	50	12	50	4.5
Experience as Mathematics teacher does have an added value in using these activities.					1	4.2	14	58.3	9	37.5	4.33
Activities are flexible and allow learners to navigate freely.					1	4.2	12	50	11	45.8	4.42
Activities motivate learning.					1	4.2	14	58.3	9	37.5	4.33
Activities are controlled by the learner.					2	8.3	10	41.7	12	50	4.42

In terms of the technical aspect, all the experts agreed that the teaching activities, which were organised to be achieved and utilised, had these characteristics: user-friendly; operating smoothly; easy to use; clear objectives; adequate contents; suitable colours, graphics and interfaces; and able to shift from one screen to another.

The Table 2 above shows the views from the experts regarding the language used in the developed activities. Overall, the developed activities contained language that was easy to be understood. All the experts gave positive responses. However, there were a few spelling errors in the developed activities.

Based on the Table 3 above, the items that represented the criteria, namely students' control, students' activities, objective, application, added value, motivation, knowledge value and flexibility showed high mean values. This means that the mathematics trainee teachers agreed that the developed activities fulfilled the paedagogical criteria, namely students' control, students' activities, objective, application, added value, motivation, knowledge value and flexibility. Among the additional comments given by the mathematics trainee teachers are that the developed activities were really helpful in students' achievement and understanding on geometry topics and that the activities were user-friendly and easy to be understood.

CONCLUSION

Effective learning strategies for mathematics are different for each area. The effective learning strategies for statistics might be different from other topics such as probability and statistics. One of the important components in mathematics is geometry. In Malaysia, 40% of the 60 topics contained in the Integrated Curriculum for Secondary School Mathematics (KBSM) from Form One to Form Five are geometry topics. Therefore, the contents of these topics are highly recommended to be arranged based on Van Hiele's phases of learning geometry. The phases include Information, Guided Orientation, Explicitation, Free Orientation and Integration. In the Information phase, a new idea is presented and students are allowed to begin working with the new concept. In the Guided Orientation phase, activities will be given to students to allow them to become familiar with the many properties of the new concept. Based on their observation in the second phase, students will express what they have discovered in their own words in the Explicitation phase. In the Free Orientation phase, students will solve problems that are more complex and require more free exploration. In the last phase, which is Integration, students will conclude what they have learned through discussion and an assignment. The implementation of Van Hiele's phased-based activities are easier and more effective with the presence of various technologies, especially with dynamic geometry software. A type of dynamic geometry software that has more advantages than others is the Geometer's Sketchpad (GSP). National Council of Teachers of Mathematics (NCTM) suggests the use of dynamic geometry software such as the GSP to help students in learning geometry. In Malaysia, a total of 29.51%, which equals to 18 mathematics topics in the secondary school mathematics curriculum from Form One to Form Five, is proposed to be taught using the GSP. In 2004, the Ministry of Education of Malaysia has obtained a licence to use the GSP for teaching and learning. This article has discussed the activities based on Van Hiele's phases of learning geometry using the GSP computer software as a tool and the developed activities were then given to eight experts to get their views regarding the activities. Since these phase-based activities obtained positive views from experts and pre-services teachers, the activities can be highly recommended to be carried out in teaching and learning geometry.

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