AC-ESI-2017

ACADEMIC CONFERENCE ON EDUCATIONAL & SOCIAL INNOVATIONS

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INTERNATIONAL COLLEGE
SUAN SUNANDHA RAJABHAT UNIVERSITY,
BANGKOK, THAILAND

RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION,
SOUTH RUSSIA INSTITUTE OF MANAGEMENT,
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Dear ladies and gentlemen, participants of Academic Conference on Educational & Social Innovations, academics and scholars, presenters of research centers, educational institutes and business!

In the era of globalization, spreading of modern knowledge and forms of education, re-evaluation of human resources for global competitiveness and self-sufficiency, an effectiveness of international collaboration in discussing on actual educational and social issues and challenges, searching for maximum effective solutions of local, regional and global development is timely increasing.

And I would like to express my deep gratitude to partnered journals, educational institutions of Thailand, Russia, Ukraine, Indonesia, Hungary and other countries whose efforts made possible this meeting of scholars and businessmen, interested in effective solution of global economy challenges using local resources of competitiveness and economical, social, cultural and innovative success.

And, of course, I would like to thank all participants for coming here, for their wonderful and useful research. I want to say, that Suan Sunandha Rajabhat University – as a leading public University of Thailand – is very proud to be an organizer of this significant and important conference.

To each participant I wish success, finding a new colleagues and friends, development of scientific and business contacts, new scientific discoveries that are benefit for society, business and government. And also enjoy your time in "golden city of Prague".

Dr. Luedeck Girdwichai, professor
President of Suan Sunandha Rajabhat University
Bangkok, Thailand

On behalf of the Organizational Committee, I welcome you to the 2017 Academic Conference on Educational & Social Innovations, in the world most beautiful and interest city of Prague! Our conference always attracts researchers, educators and practitioners in all economic fields and related disciplines in the world.

Participants have found in these meetings an excellent opportunity to share their experiences with colleagues from distance places and often continued to cooperate with them on their subjects of interest.

The AC-ESI – 2017 has been established on a global basis. We have received more than 90 submissions from 7 countries, each submission was peer-reviewed by at least two anonymous reviewers and a total of 55 papers were accepted for presentation in the conference.

Accepted papers are scheduled for presentation in 6 sessions. We would like to express our sincere appreciation to all the reviewers and chairs and members of various committees of AC-ESI -2017 conferences for their precious time and expertise. The welcoming dinner provides the opportunity to honor the best papers and to recognize the contributions of many of the people who made this meeting possible.

Lastly, I would like to express our sincere gratitude to everyone involved in making the joint conference a success. Many thanks go to the organizing committee, keynote speaker and special session organizers, and the organizational committees and reviewers, the conference participants, and of course, to all the contributing authors who will be sharing the results of their research. It is our great pleasure to have you with us at the joint conference, where I hope new ties will be made and existing ones renewed and strengthened.

Please accept our best wishes for a wonderful stay in Prague!

Asst. Prof. Dr. Kroonghong Khairirree
Director (Dean) of International College
Suan Sunandha Rajabhat University
Bangkok, Thailand
Dear friends and colleagues!

This conference is a meaningful crystallization of international initiatives among the number of institution towards practical cooperation in interdisciplinary studies, which will be contribute to the strengthening of the national educational systems.

The characteristic of the education in our era is change at the speed of light, which led us to the consensus that experts from many countries and many different disciplines must meet and discuss the phenomena, and then suggest solutions. We should be able to delve deeper by discussing problems across different disciplines as widely as possible, and thus grasping more profound solutions and suggestions.

The motivation for this conference is to help one’s country through offering individual expertise and point of view based on one’s individual discipline. As we gather from many different countries and many different disciplines, I believe that we should be able to expand the scope of our efforts and must aim at more challenging global contributions.

I hope all the participants of this conference will enjoy and get opportunities to enhance relationships of knowledge exchange.

I would like to extend my sincere gratitude to the organizing committee and especially to my Thai colleagues for given abilities to be a co-organizer and member of organizational board of AC-ESI – 2017, to be involved in the process of new international tradition formation!
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LEVELS OF GEOMETRIC THINKING AND PROOF ABILITIES OF THAI LOWER SECONDARY STUDENTS

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This survey research aimed to investigate levels of geometric thinking and proof abilities of lower secondary school students. Sample were 112 grade 8 students from 4 classes obtained from purposive sampling. Instruments were two tests, levels of geometric thinking test and proof ability test. Level of geometric thinking test was used to measure students’ level of geometric thinking. Proof ability test was used to measure students’ abilities in construction proofs in geometry. Results were the following:

1. 80% of all students passed level in order not jumping over a higher level. This result showed that most of students developed their geometric thinking satisfying the sequential property of van Hiele theory of geometric thinking.
2. 49% of all students were at level 3, informal deduction, which was one level lower than the desired level of geometric thinking in the curriculum level 4.
3. 49% of all students were at level 1 or 2 which were not the desired levels for lower secondary students.

In proof ability test, students showed the following: 1) Most of students (70%) could followed a proof, 2) 70% of all students could prove simple two-step proof, 3) when a geometric problem was given, 80% of all students could draw a diagram, write the given and the required proof, and 4) when a geometric problem with two-step proof was given, 32% of all students could draw a diagram, write the given and the required proof and finish the proof.

Key words: levels of geometric thinking and geometric proof abilities

Introduction

Geometry is an important subject in mathematics curriculum both at elementary and secondary levels. Its values are visualization, basic background in learning other mathematics topics, developing thinking skills, argumentation, proof ability, and using geometric tools.

Usiskin (NCTM, 1987) stated that geometry would still be in school mathematics curriculum because of the following reasons.

1. Geometry is the study of the visualization, drawing, and construction of figures.
2. Geometry is the study of the real, physical world.
3. Geometry is a vehicle for representing mathematical or other concepts whose origin is not visual or physical.
4. Geometry is an example of a mathematical system
The results of learning geometry of secondary school students worldwide were not satisfactory for many mathematics educators. From these unsatisfactory results, two mathematics educators, Diana van Hiele - Geldof and Pierre Marie van Hiele (NCTM, 1987) conducted a study to find out the causes. Pierre M. van Hiele collected data from many students and made conclusion as a theory of levels of geometric thought. For Diana van Hiele - Geldof, she did a study to find ways to increase students level of geometric thought to higher level. The two studies interested Soviet Union mathematics educators and they validated it. As the results, the Soviet Union improved school geometric curriculum. Many years later, the van Hiele theory of geometric thought was also validated and accepted by mathematics educators in England and America.

The van Hiele model of the development of geometric thought comprises three parts as follows: 1) The model, 2) Properties of the model, and 3) Phrases of Learning.

1) The model comprises five levels of geometric thinking as following:

Level 1 Visualization. At this initial stage, students are aware of space only as something that exists around them. Geometric concepts are viewed as total entities rather than as having components or attributes. Geometric figures, for example, are recognized by their shape as a whole, that is, by their physical appearance, not by their parts or properties. A person functioning at this level can learn geometric vocabulary, can identify specified shapes, given a figure, can reproduce it.

Level 2 Analysis. At this level, an analysis of geometric concepts begins. For example, through observation and experimentation students begin to discern the characteristics of figures. These emerging properties are then used to conceptualize classes of shapes. Thus, figures are recognized as having parts and are recognized by their parts.

Level 3 Informal Deduction. At this level, students can establish the interrelationship of properties both within figures (e.g., a quadrilateral, opposite angles being equal) and among figures (a square is a rectangle because it has all the properties of a rectangle). Thus, they can deduce properties of a figure they recognize classes of figures. Class inclusion is understood. Definitions are meaningful. Informal arguments can be followed and given. The student at this level, however, does not comprehend the significance of deduction as a whole or the role of axioms. Empirically obtained results are often used in conjunction with deduction techniques. Formal proofs can be followed, but students do not see how the logical order could be altered nor do they see how to construct a proof starting from different or unfamiliar premises.

Level 4 Deduction. At this level, the significance of deduction as a way of establishing geometric theory within an axiomatic system is understood. The interrelationship and role of undefined terms, axioms, postulates, definitions, theorems, and proof is seen. A person at this level can construct, not just memorize, proofs; the possibility of developing a proof in more than one way is seen, the interaction of necessary and sufficient conditions is understood; distinctions between a statement and its converse can be made.

Level 5 Rigor. At this stage the learner can work in a variety of axiomatic systems, that is, non-Euclidean geometries can be studied, and different systems can be compared.

Geometry is seen in the abstract. This last level is the least developed in the original works and has received little attention from researchers.

2) Properties of the model.
1. Sequential. As with most developmental theories, a person must proceed through the levels in order.
2. Advancement. Progress (or lack of it) from level to level depends more on the content and methods of instruction received than on age: No method of instruction allows a student to skip a level; some methods enhance progress, whereas others retard or even prevent movement between levels.
3. Intrinsic and extrinsic. The inherent objects at one level become the objects of study at the next level.
4. Linguistics. Each level has its own linguistic symbols and its own systems of relations connecting these symbols (P. van Hiele 1984a, p. 246).
5. Mismatch. If the student is at one level and instruction is at a different level, the desired learning and progress may not occur. In particular, if the teacher, instructional materials, content, vocabulary, and so on, are at a higher level than the learner, the student will not be able to follow the thought processes being used.

3) Phases of learning.
The van Hiele's model suggests that progress through the levels is more dependent on the instruction received than on age or maturation. Thus, the method and organization of instruction as well as the content and materials used are important areas of pedagogical concern. To address these issues, the van Hiele proposed five sequential phases of learning: inquiry, directed orientation, explanation, free orientation, and integration.

Poor performance in geometry of lower secondary students appeared throughout Thailand for years as that of the other parts of the world. Students disliked learning geometry. So, the researcher desired to investigate the current situation of learning geometry in Thailand.

Research objectives
1) To investigate students' levels of geometric thinking of lower secondary students by using van Hiele geometric thinking framework.
2) To investigate geometric proof abilities of lower secondary students.

Research questions
1) What were the distributions of levels of geometric thought of lower secondary students?
2) What was the mode of levels of geometric thinking of lower secondary students?
3) How many percent of lower secondary students passed the levels in order not jumping over any level?
4) How well could students in lower secondary follow a proof?
5) When a geometric problem was presented to a student, could the students identify the given, the statement to be proved, and draw a diagram to support the proof?
6) When a geometric problem was presented, could the students in lower secondary prove simple two-step problem?
Population and sample

Population in this study were secondary school students in Bangkok, Thailand in the academic year 2015. Sample was 112 grade 8 students from 4 classes obtained by purposeful random sampling.

Instruments

Instruments in this study were two tests as follows:

Test 1, van Hiele Geometry Test, was used to measured geometric thinking according to van Hiele geometry framework. It comprised 20 multiple - choice items for 30 minutes.

- Items 1-5 measured geometric - thinking level 1.
- Items 6-10 measured geometric - thinking level 2.
- Items 11-15 measured geometric - thinking level 3.
- Items 16-20 measured geometric - thinking level 4.

The criteria in passing each level was to get at least 3 correct items from 5 items.

Test 2, Proof Ability Test, was used to measure proof abilities. It comprised 4 written items for 50 minutes.

- Item 1 measured ability in following a proof.
- Item 2 measured ability in proving simple proof with 2 steps.
- Item 3 measured ability in drawing a diagram, writing the given, and the requirement to prove.
- Item 4 measured two-step proof with medium difficulty when a problem was given.

Results of the study

Results about students' level of geometric thinking. They were presented in Table 1.

Table 1 Students' levels of geometric thinking

<table>
<thead>
<tr>
<th>level of thinking</th>
<th>number of students passing levels in order (%)</th>
<th>number of students not passing levels in order (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>170(15.17)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>100(90.17)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>55(49.10)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>12(10.71)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>94(82.90)</td>
<td>20(17.10)</td>
</tr>
</tbody>
</table>

Table 1 showed that about 83% of students passed the levels in order and about 17% of students jumped over higher levels.

It satisfied the van Hiele theory stating that students pass level in order not jump over the levels. Most of students were at level 3 (49.10%), informal deduction. Nearly one-fourth of students (24.09%) were at levels 1 or 2 (visualization or analysis) which were the low levels. Only 10.74% of students were at level 4 which was the high level.

Results about proof abilities

Table 2 Student abilities in following a proof

<table>
<thead>
<tr>
<th>item no.</th>
<th>correct / no. of students (%)</th>
<th>incorrect / no. of students (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>95 (84.82)</td>
<td>17 (15.17)</td>
</tr>
<tr>
<td>1.3</td>
<td>110 (90.17)</td>
<td>11 (9.85)</td>
</tr>
<tr>
<td>1.4</td>
<td>81 (72.13)</td>
<td>31 (27.67)</td>
</tr>
<tr>
<td>1.5</td>
<td>85 (75.89)</td>
<td>27 (24.11)</td>
</tr>
<tr>
<td>1.6</td>
<td>69 (61.61)</td>
<td>40 (38.39)</td>
</tr>
</tbody>
</table>

Results showed that about 70% of students got correct answers. So, most students could follow the proof.

Table 3 Students' ability to fill in two-step simple proof

<table>
<thead>
<tr>
<th>statements/conclusion</th>
<th>correct / no. of students (%)</th>
<th>incorrect / no. of students (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 equality of opposite angles</td>
<td>84(75)</td>
<td>28(25)</td>
</tr>
<tr>
<td>2.2 S-A-S</td>
<td>62(55.36)</td>
<td>50(44.64)</td>
</tr>
<tr>
<td>2.3 congruence of triangles</td>
<td>76(67.86)</td>
<td>35(32.14)</td>
</tr>
<tr>
<td>2.4 equality of alternate angles</td>
<td>48(40.18)</td>
<td>67(59.82)</td>
</tr>
<tr>
<td>2.5 two lines are parallel</td>
<td>71(63.39)</td>
<td>41(36.61)</td>
</tr>
</tbody>
</table>

Table 3 showed that more than 60% of students could conclude the congruence of triangles and parallel lines. So, students could fill in two-step simple proof.

Table 4 Students' ability in drawing a diagram, writing the given, and the required proof when a problem was given

<table>
<thead>
<tr>
<th>ability</th>
<th>correct / no. of students (%)</th>
<th>incorrect / no. of students (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 drawing a diagram</td>
<td>92(82.14)</td>
<td>20(17.86)</td>
</tr>
<tr>
<td>3.2 writing the given</td>
<td>85(75.89)</td>
<td>27(24.11)</td>
</tr>
<tr>
<td>3.3 writing required proof</td>
<td>70(62.50)</td>
<td>42(37.50)</td>
</tr>
</tbody>
</table>

Table 4 showed that when a statement was given, 92% of students could draw a diagram. 85% of students could write the given. 70% of students could state the required proof.

Table 5 Students' ability to write two-step simple proof when a problem is given

<table>
<thead>
<tr>
<th>statement/conclusion</th>
<th>correct / no. of students (%)</th>
<th>incorrect / no. of students (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 AC = DC</td>
<td>55(46.43)</td>
<td>60(53.57)</td>
</tr>
<tr>
<td>4.2 A-S-A</td>
<td>32(28.57)</td>
<td>80(71.43)</td>
</tr>
<tr>
<td>4.3 congruence of triangles</td>
<td>72(64.29)</td>
<td>40(35.71)</td>
</tr>
<tr>
<td>4.4 AE=EF</td>
<td>85(75.89)</td>
<td>27(24.11)</td>
</tr>
</tbody>
</table>

Table 5 showed that only 32% of students could conclude the A-S-A condition. That is, 32% of students could complete the two-step simple proof.
Conclusion

The conclusions were divided into two parts, the levels of thinking part and proof abilities part.

Levels of thinking part. The conclusions were the following.

1. About 80% of students passed the levels in order not jumping over the higher levels. So, most of students developed their geometric thoughts in order satisfying the van Hiele theory.
2. Mode of geometric thoughts was at level 3 (55%).
3. About 40% of students were at level 1 or 2 which were the lower levels expected by the curriculum.
4. Only 12% of student were at level 4 which was the level that school geometry was taught.

Proof ability part. The conclusions were the followings:

1. Most of the students could follow the proof.
2. Students could fill in two-step simple proof.
3. When a geometric problem was given, most of students could draw the diagram, write the given and required proof.
4. For proof that students had to draw diagram, write the given and required proof, and constructed proof themselves, only 32% of students can complete the two-step simple proof.

Discussion

From this survey study, it was clearly seen that the 40% of students were at level 1 or 2 which were the lower levels expected by the curriculum. What should we do with these students to increase their level to be at least level 3? Using Technology might be one way to increase their levels. GSP software program can help them to increase their visualization, analysis, and informal deduction. The other way is investigating at the textbooks and supplementary books. Exercises which emphasize proof might be decreased but at the same time increase students' experiences on analysis, informal deduction, and conjecture. Decrease the teaching which follows Euclidean ways, but increase the same way we teach beginning algebra (Ivan Niven, 1987).

This study is one of the few studies about levels of geometric thinking in Thailand. The sample was quite small and cannot be the representation of students in other regions of Thailand. More studies are needed to get the clearer pictures of levels of geometric thinking and proof abilities.

References