Higher Order Thinking Skills and Academic Performance in Physics of College Students: A Regression Analysis

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ABSTRACT

The study determined the relationship between higher order thinking skills (HOTS) of students and the academic performance in physics. The research was conducted at Benguet State University during the school year 2010-2011 and respondents were students enrolled in Physics. Results show that 49.5% of female students have average HOTS level on analysis while 54.4% of male students have below average level. On comparison, almost 50% of both male and female students have below average level while more than half of male and female students have average level on inference. Almost half of male students and female students have average level of HOTS on evaluation. Male and female students have similar level of HOTS on all four areas. Moreover the HOTS level on analysis, comparison and evaluation significantly influence the physics performance of male students while the HOTS level on analysis, inference and evaluation significantly influence the physics performance of female students.

Keywords: Higher order thinking skills, academic performance, physics, college students, regression analysis

INTRODUCTION

The type of thinking process that students must develop to prepare them to confront the real world must go beyond simple learning of facts and content. “Knowledge obtained through higher-order thinking processes is more easily transferable, so that students with a deep conceptual understanding of an idea will be much more likely to be able to apply that knowledge to solve new problems” (*Teaching Higher Order Thinking*, n.d.). As highlighted in the website of Central Board of Secondary Education (CBSE) Physics:

> the concept of higher-order thinking skill or HOTS is a fundamental shift in evaluation reform that aims at promoting thinking skills in learners and taking them away from rote learning. Higher level mental abilities of the learners such as to analyze, interpret, reason out, synthesize or evaluate the given information are likely to enable them transfer learning to totally different situations. (http://cbse.nic.in/phycareer/hots.html).

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Across subject areas, when teachers ask higher-order questions and provide opportunities for students to develop deep explanations, learning is enhanced. Higher-order questions often start with question stems like: why, what caused, how did it occur, what if, how do they compare, or what is the evidence? When teachers ask higher-order questions and encourage explanations, they are helping their students to develop important critical thinking skills.

Physics is a unique and fascinating discipline. It's hard to teach and harder to comprehend. Physics can be considered as HOT -- higher order thinking. It makes immense academic demands on students in its learning (Adeyemo, 2010). The learning of physics is difficult at best and almost impossible at worst. But because of its enormous importance to science and technology, there is understandably huge interest in students' achievement in Physics, hence the conceptualization of this study.

BACKGROUND

Higher Order Thinking Skills

Higher-order thinking basically means thinking that is taking place in the higher-levels of the hierarchy of cognitive processing. The most widely accepted hierarchical arrangement of this sort in education is Bloom's Taxonomy, viewing a continuum of thinking skills starting with knowledge-level thinking to evaluation-level of thinking. As Hammond (n.d.) stipulates:

> Critical/creative/constructive thinking simply means thinking processes that progress upward in the given direction. First one critically analyzes the knowledge, information, or situation. Then creatively consider possible next-step options, and finally, construct a new product, decision, direction, or value. (http://xnet.rrc.mb.ca/glenh/hots.htm)

The significance of higher order thinking in the classroom is best clarified in the Department of Education, Training and Employment (DETE) Education website:

> Higher-order thinking by students involves the transformation of information and ideas. This transformation occurs when students combine facts and ideas and synthesise, generalise, explain, hypothesise or arrive at some conclusion or interpretation. Manipulating information and ideas through these processes allows students to solve problems, gain understanding and discover new meaning. When students engage in the construction of knowledge, an element of uncertainty is introduced into the instructional process and the outcomes are not always predictable; in other words, the teacher is not certain what the students will produce. In helping students become producers of knowledge, the teacher's main instructional task is to create activities or environments that allow them opportunities to engage in higher-order thinking. (http://education.qld.gov.au/corporate/newbasics/html/pedagogies/intellect/int1a.html)

Correspondingly, higher order thinking skills or HOTS include skills such as creative and critical thinking, analysis, problem solving and visualization ("Higher Order Thinking Skills", n.d.). These skills involve categorizing items, comparing and contrasting ideas and theories, and being able to write about and solve problems. In the classroom, abilities and skills that include the use of HOTS are complex thinking that goes beyond basic recall of facts, such as evaluation and invention, enabling students to retain information and to apply problem-solving solutions to real-world problems.

Thus, higher order thinking skills are valued because they are believed to better prepare students for the challenges of adult work and daily life and advanced academic work ("Higher order thinking", n.d.).

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Quellmalz Framework of Thinking Skills

Although different theoreticians and researchers use different frameworks to describe higher order skills and how they are acquired, all frameworks are in general agreement concerning the conditions under which they prosper. In this study, the Quellmalz Framework of Thinking Skills was utilized since it collects all of the elements common to many other taxonomic structures of thinking skills (Stiggins & Conklin, 1992). The levels are considered to be conceptually clear and straightforward making coding of questions easy. The four cognitive processes of analysis, comparison, inference and evaluation are collectively called higher order thinking skills (HOTS) or critical thinking skills. These are the four areas considered in the study.

Analysis include understanding relationships between the whole and its component parts and between cause and effect; sorting and categorizing, understanding how things work and how the parts of something fit together; understanding causal relationships; getting information from charts, graphs, diagrams and maps. Analysis is more than rote repetition; instead it involves reflectively structuring knowledge in new ways (Stiggins, Rubel, &Quellmalz, 1988). Comparison involves explaining how things are similar and how are they different. Comparisons may either be simple or complex. Simple comparisons are based on a small number of very obvious attributes. Complex comparisons require examination of a more extensive set of attributes of two or more things; start with the whole/part relationships in the analysis category and carry them a step further.

Inferential thinking involves reasoning inductively or deductively. In deductive tasks, students reason from generalizations to specific instances and are asked to recognize or explain the evidence. In deductive tasks, students are given the evidence or details and are required to relate and integrate the information to come up with the generalization. According to Corpuz and Salandanan (2003, pp. 68-76) as cited in Saingan (2008), "inferential thinking is an ability to form an idea, opinion or a conclusion after a series of reasoning and speculating outcomes of a situation. Students who are able to formulate conjectures, possibilities and surmise consequences based on sufficient proofs are considered capable of this higher-order thinking skill".

Evaluation, on the other hand, means expressing and defending an opinion. Evaluation tasks require students to judge quality, credibility, worth or practicality using an established criteria and explain how the criteria are met or not met. From "Quellmalz Taxonomy" (n.d.) key words such as assess, appraise, defend, argue, recommend, debate, critique are used if evaluation is to be measured.

Higher Order Thinking Skills, Gender and Academic Achievement

Across different levels, same results were shown on the relation of gender and higher order thinking skills. Both male and female students have the same level of higher order thinking skills in the grade school level (Eisenman, 1995), middle school (Song, Koszalka & Grabowski, 2005), high school level (Saingan, 2008) and in higher education (Heong, Yunos & Hassan, 2011). However, at higher academic levels, gender seems to be a factor. When critical thinking tests were given to graduate and undergraduate senior students, the gender effect was significant, with males consistently having higher critical thinking skills than females (King, Wood & Mines, 1990).

On the other hand, several studies showed mixed results on the influence of gender on academic achievement. Female students out performed male students across subject areas (Dayıoglu&Türüt-Asık, 2004; Hedges &Nowell, 1995; Linver, Davis-Kean &Eccles, 2002; Nori, 2002 as cited in Habibollah, Rohani, Aizan, Jamaluddin& Kumar, 2009); male students performed better than female students (King, Wood & Mines, 1990; Voyer, Voyer, &Bryden, 1995; Wai, Cacchio, Putallaz&Makel, 2010); girls are

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better in some areas while boys better in others (Gallagher &DeLisi, 1994 and Linn &Kessel, 1996 cited in Odell & Schumacher, 1998); no gender difference in many nations and variability of gender difference across nations (Else-Quest, Hyde & Linn, 2010); and no differences in their performance (Abubakar&Oguguo, 2011; Habibollah et al., 2009; Llanes, 2002; Moses & Daniel, 2008; Pey-ag, 2001).

THE STUDY

The studies mentioned above show conflicting results of the gender gap on achievement that a study exploring the role of gender to HOTS is also worth investigating. Unlike mixed results on gender and academic achievement, most studies cited showed that gender is not a predictor of HOTS. In the current study, the level of HOTS of college students was investigated as well as compared their HOTS level according to gender. It also investigated the relationship of the level of HOTS of students to their academic performance in physics.

Specifically the study intended to: (1) determine the level of higher order thinking skills in physics of college students grouped according to gender along analysis, comparison, inference and evaluation; (2) compare the level of higher order thinking skills of male and female students along the four areas; and (3) determine the relationship of the level of higher order thinking skills of male and female students along the four areas to academic performance in physics.

Based on the problems stated and with all the considerations mentioned above, the following hypotheses were investigated: (1) There is an average level of higher order thinking skills along analysis, comparison, inference and evaluation in physics of male and female students; (2) There are no significant differences between the levels of higher order thinking skills of male and female students along the four areas; and (3) There are no significant relationships between the levels of higher order thinking skills along the four areas and academic performance in physics of male and female students.

METHODS

Respondents

The respondents were students enrolled in Physics 11 (General Physics 1) at Benguet State University during the first and second semester of school year 2010-2011. A total of 393 students took part in the study, 112 are male and 281 are female.

Instrument

The instrument was a teacher-made test consisting of 60 multiple-choice type of questions covering topics in Physics 11 that include Kinematics, Dynamics and Statics. The area grouping of HOTS was based on the criteria of Quellmalz taxonomy (Stiggins& Conklin, 1992, pp. 159-160). The academic performance of students in physics was measured based on their final grades in Physics 11.

Data Analysis

To determine the level of higher order thinking skills of the male and female students, the frequency count was utilized. A five-point Likert Scale was used to determine the level of HOTS of the students based on their scores.

The following Likert Scale was used to measure the level of Higher Order Thinking Skills of the respondents:

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Scale	Mean Test Score	Description	Symbol Used
1	1 – 3	Low Level Higher-Order Thinking Skills	LHOTS
2	4 - 6	Below Average Level Higher-Order Thinking Skills	BHOTS
3	7 - 9	Average Level Higher-Order Thinking Skills	AHOTS
4	10 -12	Above Average Level Higher-Order Thinking Skills	AAHOTS
5	12 – 15	High Level Higher-Order Thinking Skills	HHOTS

The t-test was used to test difference in the levels of HOTS of male and female students from the HOTS average level and to determine the differences in the HOTS level of students along the four areas when grouped according to gender. Finally, the linear regression was employed to analyze the relationship between the level of HOTS along the four areas and academic performance in Physics of male and female students.

RESULTS

Higher Order Thinking Skills of Male and Female Students

Figure 1.A shows the level of higher order thinking skills along analysis of male and female students. 49.5% female students have an average level of HOTS on analysis followed by 36% with below average level. The rest have above average and low level of HOTS. On the other hand, 54.4% of male students have below average level while almost one third have average level of HOTS along analysis. The rest have above average (6.1%) and low (3.5%) levels of HOTS along analysis.

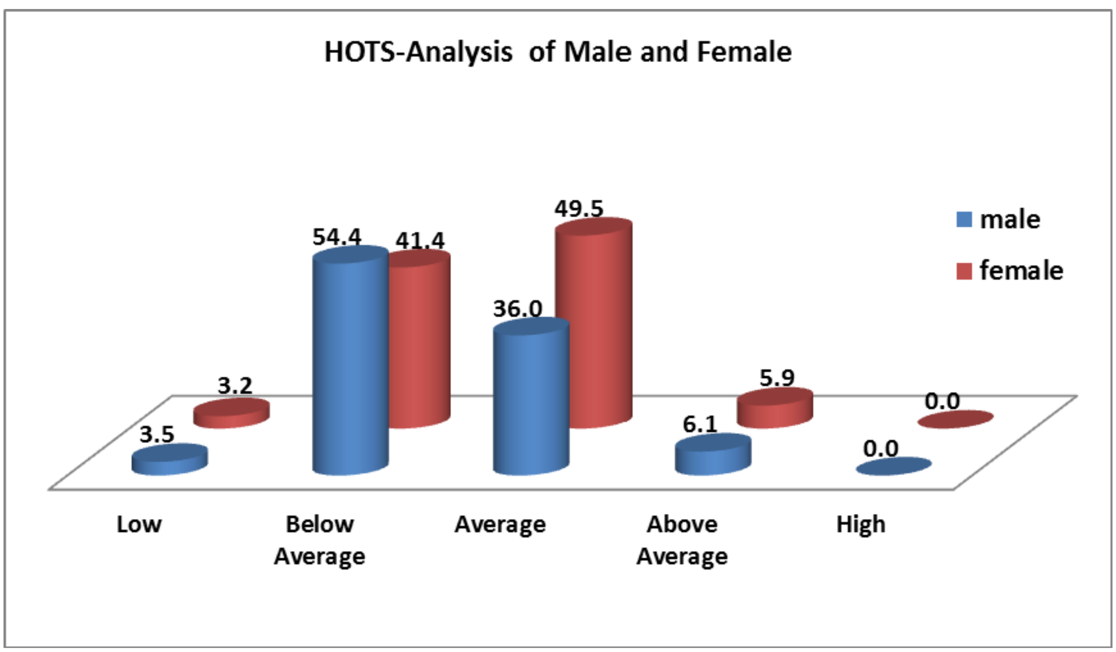

Figure 1.A. Level of higher order thinking skills along analysis of male and female students.

Figure 1.B presents the level of Higher Order Thinking Skills along comparison of male and female students. 48.6% of female students have below average level of HOTS along comparison, 32.3% have

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average level while 13.6% have low level and only 5.50% have above average level. For the male respondents, 57.9% have below average level, 29.8% have average level, 8.80% have low level while only 3.5 % have above average level of HOTS along comparison.

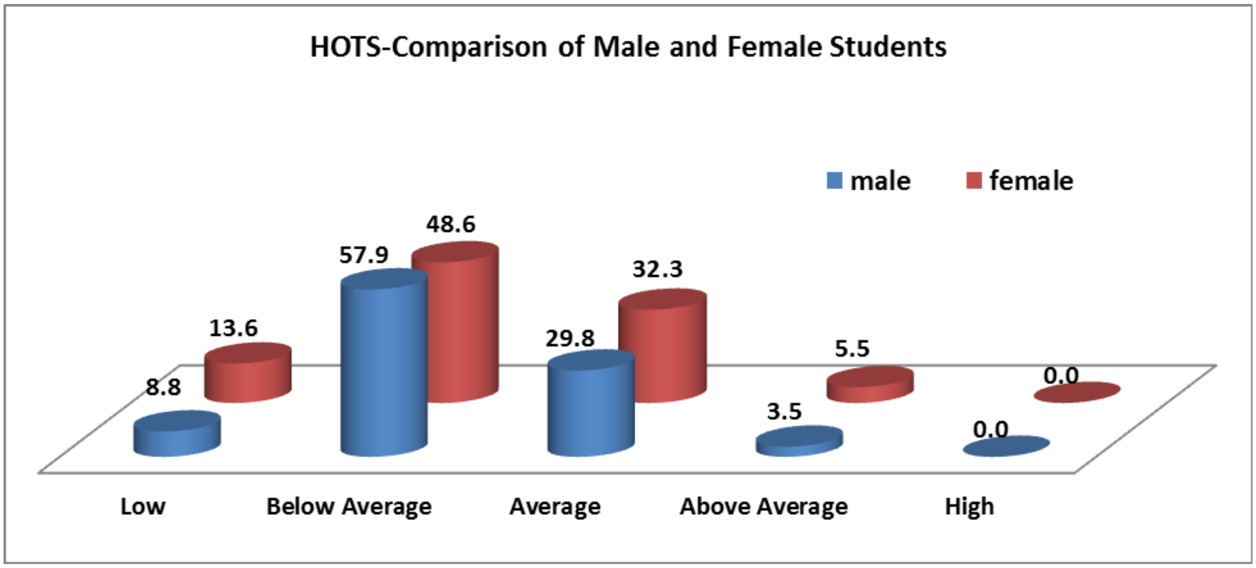

Figure 1.B. Level of higher order thinking skills along comparison of male and female students.

Figure 1.C presents the level of higher order thinking skills along inference of male and female students. 55% of female students have average level of HOTS along inference followed by 35% having below average level and 2.7% with low level of HOTS. For the male students, 63.2% average level of HOTS on inference 29.4% have below average while 6.1% have above average level and only 0.9% have low HOTS level non inference.

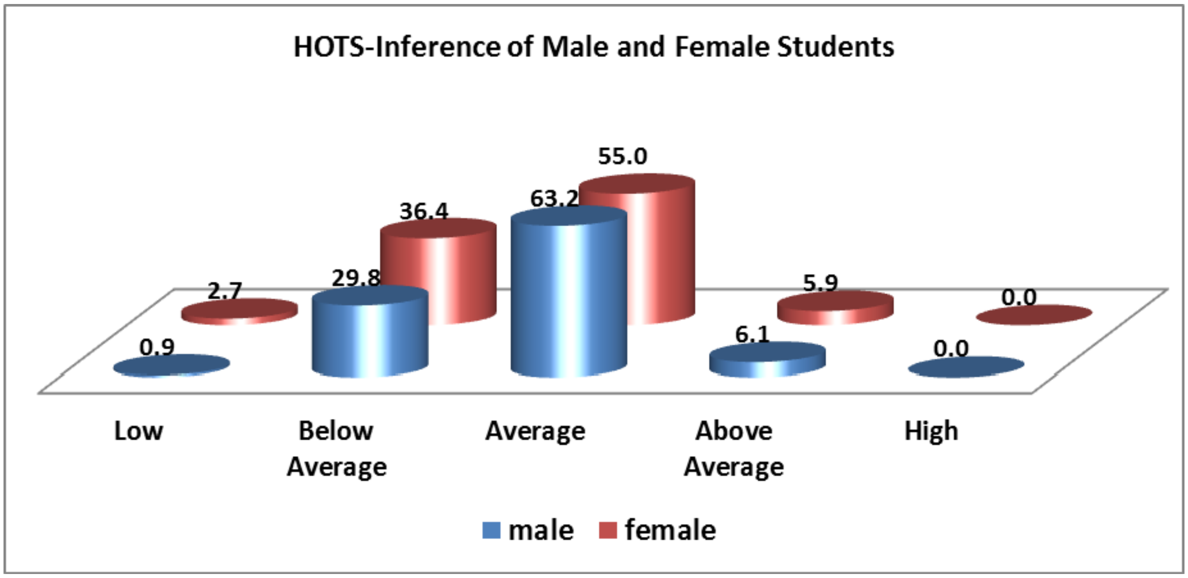

Figure 1.C. Level of higher order thinking skills along inference of male and female students.

Figure 1.D. presents the level of higher order thinking skills along evaluation of male and female students. 40.9% of female students have below average HOTS level on evaluation, 40.5% have average level while almost 10% each have low or above average level. For male respondents, 45.6% have below

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average level, 30.7% average level, 13.2% above average level and about 10% have low level of HOTS along evaluation.

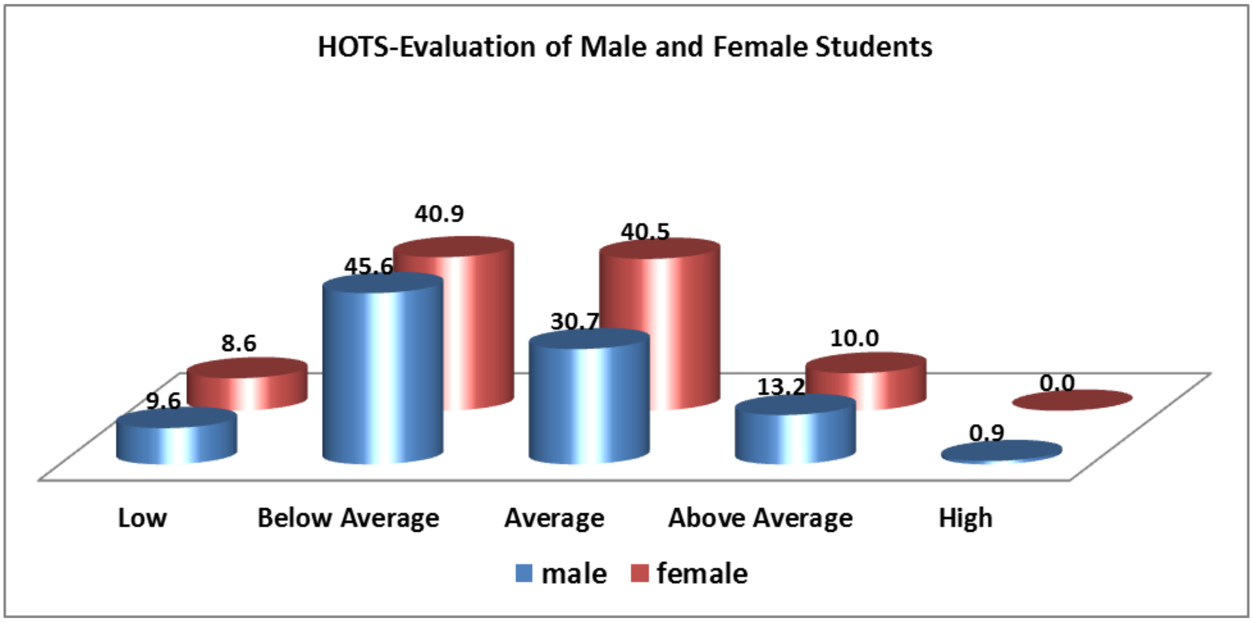

Figure 1.D. Level of higher order thinking skills along evaluation of male and female students.

Table 1 presents the comparison of the level of higher order thinking skills of male and female students along analysis, comparison, inference and evaluation from the HOTS average level. For male students, the t values of all areas were found to be significant at 0.01 level of significance. This implies that the level of HOTS of male students along the four areas differ significantly from the HOTS average level. Hypothesis 1 for male students is therefore rejected. The levels of higher order thinking skills along the four areas of male students are below average.

Similarly, the t values of each area for female students are found to be significant at 0.01 level of significance. The HOTS level of female students along all four areas differ significantly from the HOTS average level. Therefore, hypotheses 1 for female students is rejected. The levels of higher order thinking skills along the four areas of female students are below average.

Table 1.Comparison of the level of higher order thinking skills of male and female students from the HOTS average level.

Higher order	t - values	
thinking skill (HOTS)	MALE	FEMALE
Analysis	34.74**	54.44**
Comparison	33.32**	39.63**
Inference	49.05**	61.08**
Evaluation	28.29**	43.17**

***Highly significant*

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Comparison of Higher Order Thinking Skills of Male and Female Students

Table 2 presents the comparison among the level of higher order thinking skills along analysis, comparison, inference and evaluation of male and female students. The t values of all areas are not significant. This implies that the level of HOTS of male and female students do not differ significantly. Hypothesis 2 is therefore accepted. Male and female students have the same HOTS level along the four areas.

Table 2. Comparison among the level of higher order thinking skills of male and females students

Higher order thinking skill (HOTS)	t – values MALE-FEMALE	Sig
Analysis	1.809	0.161ns
Comparison	0.962	0.225ns
Inference	1.429	0.121ns
Evaluation	0.568	0.387ns

ns – not significant

Relationship of Level of Higher Order Thinking Skills and Academic Performance in Physics of Male and Female Students

The regression equation shows the relationship between the four areas of higher order thinking skills with physics performance of male and female students. The first equation shows that the levels of HOTS on analysis, evaluation and comparison have significant influence to academic performance of male students in physics as indicated by $\rho < 0.05$ level of significance. On the other hand, the level of HOTS on inference does not have a significant influence to physics performance of male students as indicated by $\rho > 0.05$. Hypotheses 3 are therefore rejected for analysis, comparison and evaluation, while hypothesis 3 is accepted for inference. The higher the level of HOTS of male students on analysis, comparison and evaluation, the better is their performance in physics.

Y_M = 3.419 - 0.035Analysis - 0.026Comparison - 0.020inference - 0.072evaluation

(<0.01) (<0.01) (<0.05) (>0.05) (<0.01)

The second equation shows that among the four areas, the levels of HOTS on analysis, inference and evaluation have significant influence to the physics performance of female students as indicated by $\rho <$ 0.05 level of significance. However, the level of HOTS on comparison has no significant influence to the physics performance of female students. Hypotheses 3 are therefore rejected for analysis, inference and evaluation to female students while that for analysis is accepted. The higher the level of HOTS on analysis, inference and evaluation of female students, the better is their physics performance.

Y_F = 3.413 - 0.014Analysis - 0.025Comparison - 0.037inference - 0.082evaluation

(<0.01) (<0.05) (>0.05) (<0.05) (<0.01)

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DISCUSSION AND RECOMMENDATIONS

The study shows that college students do not have the necessary skills needed in Physics. This is consistent with the observation of Cotton (1991) “students, in general, do not have well-developed thinking skills” (p. 10). Students should be exposed to instructional approaches that promote higher order thinking skills. Research has shown that these skills can be significantly enhanced through interventions (Hopson, Simms & Knezek, 2001; Ives & Obenchain, 1996; Jackson, 2000 as cited in Koczij, 2005, pp. 5-6; Saingan, 2008; Zohar & Dori, 2003). Teachers should encourage students to engage in tasks that involve higher order thinking skills (Zohar & Dori, 2003). Nevertheless “the development of these skills requires practice, and that the more work students have in a particular discipline, the more able they will be to demonstrate these sorts of educational outcomes” (Haller, Monk & Tien, 1993, p. 67).

Teacher training is a key factor in the success of fostering HOTS inside the classroom. It is associated with student achievement gains (Cotton, 1991). There is a need for physics teachers’ trainings as only a minority of teachers view fostering of higher-order thinking as an important objective of teaching physics (Barak & Shakhman, 2008). Additionally, these trainings should be extensive since “teachers are not likely to implement new approaches that they have learned about in teacher education programs unless their training in new approaches is continuous, large scale, offers incentives, and can be done without a significantly greater time commitment”(Levine, 1994 as cited in Ives and Obenchain, 2006, p. 73).

There seems to be no gender gap in the physics classroom as far as level of higher order thinking skills of students is concerned. This non-significant role of gender also concurs with the findings of Abubakar and Oguguo (2011), Habibollah et al. (2009), Llanes (2002), Moses and Daniel (2008) Pey-ag (2001) and Saingan (2008). Male and female students should be given equal opportunities to develop their higher order thinking skills in the physics classroom. Strategies to be adopted by physics teachers should be designed to appeal to both groups. Consequently, it can be surmised that the teacher plays a critical role for these strategies to be effective. “Different instructors may enact these teaching strategies differently; and instructors set the tone, norms of behavior, and attitude in the class both explicitly and implicitly” (Pollock, Finkelstein & Kost, 2007, p. 2). As emphasized by Baird (1997),”through their attitudes and actions, teachers have the potential to make a significant positive or negative impact on gender balance in physical science” (Chap.6, para. 5).

On the relationship of level of higher order thinking skills along the four areas and academic achievement in physics, level of HOTS of students influence the physics performance of male and female students. Analysis and evaluation are skills closely associated to problem-solving skills, so a mathematical approach in teaching physics could be beneficial to male students in getting better grades in physics. For female students, activities that require them to maximize their evaluation will be helpful in their physics performance. These results are in agreement with the findings of Rodrigues and Oliveira (2008) when they pointed out that “critical thinking level is a predictor of the pupils’ performance in physics” (p. 6). This finding is not surprising since Physics is considered as a higher order thinking or HOT subject, hence, the importance of fostering such skills in the physics classroom. As Rodrigues and Oliveira (2008) stated in their conclusion:

> It’s time to change physics teaching. Teaching physics is still too frequently centered on a transmissive approach demanding the memorization of physics equations, principles and laws or the performance of mere exercises based on a drill approach. This way of learning physics is boring and uninteresting

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> for young people and does not meet the actual requirements of society and of the new trends of physics curricula (p. 6).

CONCLUSION

Results of the study call for push toward higher-order thinking skills in the classroom. These skills are necessary for people to have in this rapidly changing, technologically oriented world. Instruction in thinking skills promotes intellectual growth and fosters academic achievement gains (Cotton, 1991). The importance for students to develop these skills is asserted in "Teaching Higher-Order Thinking" (n.d.):

> Information learned and processed through higher-order thinking processes is remembered longer and more clearly than information that is processed through lower-order, rote memorization. Knowledge obtained through higher-order thinking processes is more easily transferable, so that students with a deep conceptual understanding of an idea will be much more likely to be able to apply that knowledge to solve new problems (p. 55).

It can be noted from the results that the higher the level of HOTS of students, the better their performance in physics. There is a need to enhance such skills in the physics classroom as substantiated by McLoughlin and Hollingworth (2001) when they suggested:

> The learning environment for science should encourage students to engage in higher-order thinking activities. Teachers of science subjects need to move away from an over-emphasis on content mastery and adopt pedagogies that enable the development of thinking processes. Graduates cannot rely on recall of content knowledge alone to operate effectively in the workplace, but must also be equipped with the procedural, strategic and metacognitive knowledge to solve complex problems. Students need adequate practice and opportunities to develop these skills, and must be able to manage their own learning (p.8).

Accordingly, with appropriate pedagogical strategies along with teacher possessing proper training and right motivation, HOTS of students can be enhanced (Cotton, 1991; Haller et al., 1993; Ives &Obenchain, 1996).

REFERENCES

Abubakar, R.B., & Oguguo, O.D. (2011). *Age and gender as predictors of academic achievement of college mathematics and science students*. Presented at the Proceedings of the 2011 International Conference on International Association for Teaching and Learning: Teaching, Learning and Change. Retrieved March 2011 from http://www.hrmars.com/admin/pics/186.pdf

Adeyemo, S.A. (2010). Background and classroom correlates of students' achievement in Physics. *International Journal of Educational Research and Technology, Vol 1 [1] June 2010: 25 – 34.* Retrieved from http://www.journals.elsevier.com/international-journal-of-educational-research/

Baird, D. (1997). *Is the physics classroom any place for girls? The gender imbalance in physics education: How it came about and what teachers can do about it*. Master's Thesis. Retrieved April 2011 from http://homepage.mac.com/phyzman/phyz/thesis.htmlgender

ISSN 1839-9053

Barak, M., & Shakman, L. (2008, June). *Fostering higher-order thinking in science class: Teachers' reflections.* Abstract retrieved from ERIC Database. (EJ 811893)

Central Board for Secondary Education Physics. (n.d.). *HOTS in Physics*. Retrieved from http://cbse.nic.in/phycareer/hots.html

Cotton, K. (1991). *Close-up #11: Teaching thinking skills*. Retrieved from http://educationnorthwest.org/webfm_send/502

Department of Education, Training and Employment Education. (n.d.). Retrieved August 2010 from http://education.qld.gov.au/corporate/newbasics/html/pedagogies/intellect/int1a.html

Dayıoglu, M., & Türüt-Asık, S. (2004). *Gender differences in academic performance in a large public university in Turkey*. ERC Working Papers in Economics. Retrieved from http://www.erc.metu.edu.tr/index.html

Eisneman, J.G. (1995). *An evaluation of the higher order thinking skills program with fourth and fifth grade students*. Abstract retrieved from ERIC Database. (ED 393873).

Else-Quest, N.M., Hyde, J.S. & Linn, M.C. (2010). Cross-national patterns of gender differences in Mathematics: A meta-analysis. *Psychological Bulletin. American Psychological Association, 136,* (1), 103–127. doi: 10.1037/a0018053103

Habibollah, N., Rohani, A., Aizan, H.T., Janaluddin, S. & Kumar, S. (2009). Creativity, age and gender as predictors of academic achievement among undergraduate students. *Journal of American Science 2009;5(5):101-112*. Retrieved from http://www.jofamericanscience.org/

Haller, E.J., Monk, D.H., & Tien, L.T. (1993). Small schools and higher-order thinking skills. *Journal of Research in Rural Education, Fall, 1993,Vol. 9, No.2, 66-73.* Retrieved from http://jrre.psu.edu/

Hammond, G. (n.d.). *Higher order thinking.* Retrieved June 2010 from http://xnet.rrc.mb.ca/glenh/hots.htm

Hedges, L. V. , & Nowell, A. (1995). Sex differences in mental test scores, variability, and numbers of high-
scoring individuals*. Science, 269, 41-45.* DOI: 10.1126/science.7604277

Heong, Y.M., Yunos, J. B., & Hassan,R. B. (2011). *The perception of the level of higher order thinking skills among technical education students*. Paper presented at the 2011 International Conference on Social Science and Humanity, IPEDR vol.5, 2011. DOI: 10.7763/IPEDR

Higher Order Thinking. (2010). Retrieved from http://www.cantthink.com/HigherOrderThinkingSkills.html

ISSN 1839-9053

Higher Order Thinking.(n.d.). Retrieved from http://www.learnnc.org/reference/higher%20order%20thinking

Hopson, M.H., Simms, R. L., & Knezek, G.A. (2001). Using a technology-enriched environment to improve higher-order thinking skills. *Journal of Research on Technology in Education, Winter 2001-2002: Vol. 34, 2,* 109-119. Retrieved from http://www.iste.org/learn/publications/journals/jrte

Ives, B., & Obenchain, K. (2006). Experiential education in the classroom and academic outcomes: For those who want it all. *Journal of Experiential Education, Volume 29* (1), 61-77. Retrieved from http://www.aee.org/publications/jee

King, P.M., Wood, P.K., & Mines, R.A.(1990). Critical thinking among college and graduate students. *The Review of Higher Education. Winter 1990, Volume13* (2), 167-186. Retrieved from http://www.press.jhu.edu/journals/review_of_higher_education/

Koczij, M. (2005).Annotated bibliography of research on higher order thinking. Retrieved August 2010 from http://mr.koczij.com/resources/dyc/MrKoczij_learning_higherorder_annotated.pdf

Linver, M.R., Davis-Kean, P., & Eccles, J.E. (2002, April).*Influences of Gender on Academic Achievement.*Presented at the biennial meetings of the Society for Research on Adolescence, New Orleans, LA. Retrieved March 2011 from http://rcgd.isr.umich.edu/garp/articles/linver02.pdf

Llanes, E. (2000). *Performance of fourth year high school students in science and technology IV of the Ilocos Sur Polytechnic College, Tagudin Campus, 1999 – 2000*.Unpublished Master's thesis, Baguio Central University, Baguio City.

Mcloughlin, C., & Hollingworth, R.W. (2001). Even foundation level students can get the HOTS for science! Retrieved March 2010 from http://www.fyhe.com.au/past_papers/papers03/Refereed%20Papers/Full%20papers/McLoughlin&Hollingworth_final.doc

Moses, A., & Daniel, O. (2008). Gender difference in integrated science achievement among pre service teachers in Nigeria. *Educational Research and Review Vol. 3 (7), pp. 242-245*. Retrieved from http://www.academicjournals.org/err/index.htm

Odell, P.M., & Schumacker, P. (1998).Attitudes toward mathematics and predictors of college mathematics grades-gender differences in a 4-year business college. *Journal of Education for Business, 74 (1)*: 34-38. Retrieved from http://www.tandfonline.com/

Pey-ag, J. (2001).*Difficulties encountered by the seniors in word problems in math in public secondary schools, Sabangan, Mountain Province, 1999 – 2000*. Unpublished Master's Thesis.Baguio Central University, Baguio City.

Pollock, S. J., Finkelstein, N. D., & Kost, L. E. (2007). Reducing the gender gap in the physics classroom: How sufficient is interactive engagement? *Physical Review Special Topics - Physics Education*

ISSN 1839-9053

Research 3. DOI: 10.1103/PhysRevSTPER.3.010107

Quellmalz Taxonomy. (n.d.). Retrieved June 2010 from http://www.coorisd.k12.mi.us/jhaf/class-assess-101-d-bloom-quellmalz-1.htm

Rodrigues,A.and Oliveira,M. (2008).The role of critical thinking in physics learning. Retrieved from http://lsg.ucy.ac.cy/girep2008/papers/THE%20ROLE%20OF%20CRITICAL%20THINKING.pdf

Saingan,R. (2008).Demonstration strategy and achievement of physics students based on higher order thinking skills. *Graduate School Journal, Vol.14,* 129 – 135. Graduate School, Benguet State University.

Song, H., Koszalka, T. A., & Grabowski, B. (2005). Exploring Instructional Design Factors Prompting Reflective Thinking in Young Adolescents.*Canadian Journal of Learning and Technology, Vol 31, No. 2,* 49-68. Retrieved from http://cjlt.csj.ualberta.ca/index.php/cjlt

Stiggins, R., & Conklin, N. (1992).*In Teachers' Hands: Investigating the Practices of Classroom Assessment, p. 158.* Retrieved from http://www:books.google.com.

Stiggins, R.J., Rubel, E., and Quellmalz, E. (1988).*Measuring Thinking Skills in the Classroom.* (Revised Ed.). Washington, DC: National Education Association.

Teaching Higher-Order Thinking.(n.d.). Retrieved March 2011 from http://teachingasleadership.org/sites/default/files/Related-Readings/LT_Ch5_2011.pdf

Voyer, D., Voyer, S., & Bryden, M.P.(1995). Magnitude of sex differences in spatial abilities: A meta-analysis and consideration of critical variables . *Psychological Bulletin, American Psychological Association 1995, 117,* 250-270. doi: 10.1037/a0018053103

Wai, J., Cacchio, M., Putallaz, M., & Makel , M.C. (2010). Sex differences in the right tail of cognitive abilities: A 30 year examination. *Intelligence, Vol. 38*, 412–423. doi:10.1016/j.intell.2010.04.006

Zohar, A., & Y. Dori. (2003). Higher order thinking skills and low-achieving students: are they mutually exclusive? *Journal of the Learning Sciences, Volume 12 (2)* 145 – 181. Retrieved from http://www.jstor.org/pss/1466891

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