JPII 11(2) (2022) 314-321

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

THE EFFECT OF 21ST-CENTURY LEARNING ON HIGHER-ORDER THINKING SKILLS (HOTS) AND NUMERICAL LITERACY OF SCIENCE STUDENTS IN INDONESIA BASED ON GENDER

N. Sepriyanti*[1], S. Nelwati[2], M. Kustati[3], J. Afriadi[4]

[1,2,3,4]UIN Imam Bonjol Padang, Padang, Indonesia

DOI: 10.15294/jpii.v11i2.36384

Accepted: April 29th 2022. Approved: June 27th 2022. Published: June 30th 2022

ABSTRACT

This study discusses the importance of 21st-century learning to improve students' higher-order thinking skills and numerical literacy based on gender. This research is descriptive quantitative, and correlational. The subjects of this study were education and science students from nine public Islamic universities in Indonesia who were selected by purposive sampling and took statistics courses in the odd semester of 2021/2022 in terms of gender. The sample size is 213 students, with 87 males and 126 female students. Data collection method used questionnaires, observation sheets, and HOTS and numerical literacy tests. The results show that the 21st-century competency-based learning process to improve HOTS and numerical literacy of Public Islamic university students in Indonesia was in the very good category (81.67%). Students' responses to the learning process were in the very good category (81.78%). Male students' HOTS were higher than female students, and male students' numerical literacy skills were lower than female students. In summary, these results suggest that gender partially influences and relates to HOTS and numerical literacy of students at nine public Islamic universities in Indonesia with a low correlation.

Keywords: 21-century learning; gender; higher-order thinking skills; numerical literacy

INTRODUCTION

The industrial revolution 4.0, which began in the 21st-century, is characterized by openness, globalization, and substantial shifts from the 20th -century's way of life. The 21st-century inevitably calls for high-caliber human resources, which institutions with professional management create for superior outcomes. These brand-new requirements necessitate a number of innovations in ways of thinking, formulating ideas, and acting. Higher-order thinking skills (HOTS) are needed to solve problems considering the needs of these 21st-century skills (Yen & Halili, 2015; Lubis et al., 2019; Ichsan et al., 2020). HOTS is one of the emphasized elements of creating high-quality human resources (Misrom et al., 2020). One will face unusual problems, so HOT is a skill that students in the 21st-century must possess to prepare them to solve various problems in the future, which consists of analyzing, evaluating, and creating (Widiawati et al., 2018). Heong et al. (2016), in their research, suggest that HOTS is needed to determine the quality of one's thinking in fostering a positive attitude in developing skills.

HOTS develops in students through various thinking processes, from low to high levels simultaneously. On the other side, HOTS is a mental process that allows students to develop factual, procedural, conceptual, and metacognitive knowledge in critical and creative domains (Utami, 2016; Hobri et al., 2018). In other words, HOTS is a component of critical thinking and creative thinking skills that can be innovative, creative, and imaginative (Abosalem, 2016; Ahmad et al., 2017; Syahlan & Saragih, 2020). In order to ac-

***Correspondence Address**
E-mail: nanasepriyanti@uinib.ac.id

complish a goal or find a solution to a challenging circumstance, a person uses fresh information to connect, rearrange, and develop information previously stored in his memory. This is known as HOTS (Irawati & Mahmudah, 2020).

HOTS provides various benefits to students. The benefits of having HOTS are thinking reflectively and creatively, solving problems, thinking critically and metacognitively caused by implementing HOTS to make decisions (Snyder & Wiles, 2015). Another benefit is that it gives a person a paradigm to develop a career, excel in learning, develop social skills, be responsible, be self-controlled, work hard and creatively, solve problems, and make decisions and plans (Wang & Wang, 2014). In addition, HOTS can improve good skills, so the HOTS approach needs to be developed (Kurniawan & Lestari, 2019; Puspitasari & Nugroho, 2020). All the benefits offered by HOTS enable a person to be ready to face the times. Therefore, learning is needed to improve HOTS.

In line with the development of knowledge and having high-level thinking skills, students are also required to have literacy skills in this industrial era. Literacy skills must be developed and applied in various fields, including information, media, scientific, mathematical, and numerical literacy. Numerical literacy is a person's ability to engage in the use of reasoning. Reasoning means understanding and analyzing a statement by manipulating mathematical language found in everyday life and expressing it orally and in writing (Aunio & Räsänen, 2016; Han et al., 2017; Ekowati et al., 2019; Abidin et al., 2021). Numerical literacy is strongly tied to the ability to organize facts, transform objects into symbols, and choose the appropriate formula to calculate an object (Parnis & Petocz, 2016). Good numeracy literacy will give birth to someone skilled in using mathematics confidently in school learning and everyday life (Tout, 2020; Nudiati & Sudiapermana, 2020). Numerical literacy is an essential skill for students pursuing careers in a variety of disciplines to live a fulfilling life in the future (Jonas, 2018). Fulfilling HOTS needs to be based on numerical literacy skills (Pangesti, 2018). HOTS and literacy are benchmarks for learning success in Indonesia.

Sumule et al. (2018) state that one indicator that shows the low quality of education in a country is the result of international assessments of students' achievement. Students' achievement has not followed the importance of HOTS and mathematical literacy in Indonesia. The results of the PISA study in mathematics in 2018 show Indonesia is ranked 72 out of 78 participating countries (OECD, 2019; Junika et al., 2020). The PISA study's findings, which indicate that Indonesia consistently ranks in the lowest 10% of nations and that nearly no Indonesian students achieve the two highest levels, reveal the same issue (levels 5 and 6) (Mullis et al., 2012; OECD, 2013, 2015; Risdiyanti & Prahmana, 2017). In Malaysia, educators strive to increase students' HOTS at various levels of education (Tajudin & Chinnappan, 2016; Ramlee et al., 2019). Students' and teachers' high-level skills are still deficient (Rosmaiyadi, 2017). Only some students could solve the problem, and some had difficulty. Difficulties have caused students to make various mistakes (Abdullah et al., 2015). Students who are at a higher level, such as high school, should not only have low-order thinking (LOT) but also have to achieve higher-order thinking (HOT) (Merta Dhewa et al., 2017). Therefore, improvements are needed in various aspects of education in Indonesia.

The quality of teachers and lecturers is an essential part of the progress of a country. Finland is a developed nation whose economy is backed by science-based technology innovation after transitioning from a traditional agrarian, industrial nation. This development is attributable to the excellent teachers who were well-prepared before teaching (Kola & Sunday, 2015). Unlike in Indonesia, teachers frequently use questions in supporting books dominated by remembering and understanding indicators (Hassan et al., 2016). Meanwhile, there are few questions with indicators for analyzing, evaluating, and creating in supporting books (Musfiqi & Jailani, 2014; Fielding-wells, 2016). It causes students only to solve problems using formulas without analyzing, evaluating, and creating (Musfiqi & Jailani, 2014).

For this reason, it is necessary to have quality questions that include these three indicators (Tanujaya, 2016). Students also have difficulty developing their reasoning or thinking skills at a high level (Agustyaningrum & Yusnita, 2017). The ability of students to solve math problems is influenced by the pattern of problem-solving when students are in elementary and middle schools. The habit of answering multiple-choice questions at the national exam has affected students' ability to solve descriptive questions in higher education, especially proof questions (Utami, 2016).

Besides the stakeholder issues in the education field, gender differences have been in the spotlight for a long time. They are a term wide-

ly used in our daily lives, including in schools and education. Mulyani and Muhtadi's research (2019) found the effect of gender in solving HOTS-type questions on trigonometry. The female gender has a lower percentage of errors at the transformation than the male gender, and the female gender has a higher percentage of errors at the comprehension, process skill, and encoding stages than the male gender (Mulyani & Muhtadi, 2019). According to some experts, gender inequalities in mathematics are caused by biological variations between male and female brains, which may be seen in the fact that women are typically better at language and writing. Men also perform better in mathematics because they have greater spatial abilities. Males typically focus on abstract, intellectual, and objective, while females typically focus on personal, emotional, practical, and concrete (Kusumawati & Nayazik, 2017). Females will take more complete and thorough notes and dictating lessons than men, but usually, these notes are less critical (Dilla et al., 2018). It can be said that biologically and psychologically, there are indeed differences between males and females. Differences that sometimes favor males over females in learning or vice versa.

Based on the conditions and facts described above, this study aims to analyze HOTS skills and numerical literacy skills students after learning through 21st-century learning when viewed by gender. The differences between males and females in learning are not meant to ignore gender equality. It aims to assist teachers and lecturers in designing learning processes and media because of biological and psychological differences.

METHODS

This research is descriptive quantitative, correlational, and regression. The population of this research is all Public Islamic university students in Indonesia. Public Islamic universities are under the responsibility of the Ministry of Religion. There are three types of universities that fall into this category: Public Islamic University (UIN/*Universitas Islam Negeri*), Public Islamic Institute (IAIN/*Institut Agama Islam Negeri*), and Public Islamic Higher School (STAIN/*Sekolah Tinggi Agama Islam Negeri*). There are 58 public Islamic universities consisting of 23 UIN, 30 IAIN, and 5 STAIN. The sample of this research is nine public Islamic universities in Indonesia using the purposive sampling technique. The nine public Islamic universities are UIN Syarif Hidayatullah Jakarta, IAIN Manado, IAIN Sorong, IAIN Takengon, IAIN Batusangkar, UIN Prof. KH Saifuddin Zuhri Purwokerto, UIN Sunan Kalijaga Yogyakarta, UIN Sutan Kasim Riau, and UIN Imam Bonjol Padang. The sample size is 213 students, with 87 males and 126 female students. The students were chosen randomly from education and science students from nine public Islamic universities in Indonesia who were selected by purposive sampling and took statistics courses in the odd semester of 2021/2022 that would review students' HOTS and numerical literacy skills from a gender perspective. According to Aba et al. (2022), gender generates differences in the structure and functional history of male and female brains, which go beyond biological differences.

The instruments employed in this study were observation sheets, questionnaires, HOTS and numerical literacy tests. Instrument in the preparation phase, the test specification is made. Cation, creation, revision, and modification of test questions, improve test questions and develop assessment guidelines, and explain and determine the integrity standard. The implementation phase is testing and analyzing answers to questions, and I explain the test results. HOTs and Numerical literacy skill test devices are built on indicators. The instrument for measuring HOTS was two sets of tests referring to the 4th (analysis) and 5th (evaluation) level of the revised Bloom's taxonomy (Conklin, 2005). Qualitative data on the implementation of 21st-century learning were collected using observation sheets and student response questionnaires. Quantitative data in HOTS and numerical literacy were measured using tests. Meanwhile, gender categorical data were collected through attendance data for lecturers who teach at each public Islamic university that became the research sample.

Before statistical tests, the normality and homogeneity of variance tests were first carried out in the data group. Manova analysis describes the effect of gender on HOTS and numerical literacy and is continued with the Mann-Whitney U test to see the validity of the effect. Pearson's correlation test describes the partial relationship between gender and HOTS and gender and numerical literacy. A simple regression test sees the relationship and influence of numerical literacy on HOTS. Qualitative data obtained from questionnaires on student responses to 21st-century learning models and observations of students' learning activities were analyzed with descriptive statistics. All statistical tests were performed at a significance level of 5%.

RESULTS AND DISCUSSION

The results of this study indicate an influence of gender on HOTS and numerical literacy. It can be noted in the following table of multivariate test results.

Table 1. Multivariate Test

	Effect	Value	F	Sig.
Gender	Pillai's Trace	.097	11.336[a]	.000
	Wilks' Lambda	.903	11.336[a]	.000
	Hotelling's Trace	.108	11.336[a]	.000
	Roy's Largest Root	.108	11.336[a]	.000

a. Exact statistic
b. Design: Intercept + Gender

From Table 1, we can conclude that based on the Wilks' Lambda value of F=11.336 with sig 0.000 < 0.05, there are differences in students' HOTS and numerical literacy regarding gender. The following is data on male and female students' HOTS and numerical literacy through the Mann-Whitney U non-parametric statistical test.

Table 2. Statistics Tests

	HOTS	Numerical literacy
Mann-Whitney U	4071.500	4531.000
Wilcoxon W	12072.500	8359.000
Z	-3.194	-2.153
Asymp. Sig. (2-tailed)	.001	.031

a. Grouping Variable: Gender

The Sig or P-Value in the HOTS column is 0.011 < 0.05, meaning a significant difference between the HOTS of male and female students who study with 21st-century learning. While the Sig or P-Value in the numerical literacy column is 0.031 < 0.05, meaning that there is a significant difference between the numerical literacy skills of male and female students who study with 21st-century learning. Table 3 shows the relationship between gender and HOTS and numerical literacy.

Table 3. Test of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Gender	HOTS	372.991	1	372.991	11.916	.001
	Numerical Literacy	184.420	1	184.420	4.496	.035

Based on Table 3, we can interpret the relationship between gender and HOTS and gender and numerical literacy from their respective significance values of 0.001 and 0.035, where both are less than 0.005. It means a relationship between gender and HOTS and gender and numerical literacy. We can analyze the strength or weakness of the relationship between these variables through Pearson's correlation test.

Table 4. The Correlation between Gender and HOTS and Numerical Literacy

Independent Variable	Dependent Variable	R-Value	Explanation
Gender	HOTS	-0.231	Low
	Numerical Literacy	0.144	Low

Based on the correlation analysis in Table 4, it is known that the correlation coefficient is 0.144 and -0.231, which means that the two variables have a low level of relationship. The negative correlation coefficient between gender and HOTS indicates that the relationship between the two is inversely proportional, where the average male HOTS (27.62) is higher than females (24.93). Meanwhile, the positive correlation coefficient between gender and numerical literacy shows a unidirectional relationship, where male numerical literacy (24.11) is lower than female (26.01). The descriptive average difference is in the following table.

Table 5. Descriptive Statistics

	Gender	Mean	Std. Deviation	N
HOTS	Male	27.62	6.093	87
	Female	24.93	5.225	126
	Total	26.03	5.737	213
Numerical Literacy	Male	24.11	6.229	87
	Female	26.01	6.523	126
	Total	25.23	6.458	213

The difference in ability between male and female students is influenced by several factors, including students' activities and involvement in 21st-century skills-based learning processes. Students' involvement in learning is in Table 6.

Table 6. Students' Activities and Involvement

Aspects	Gender	
	Male (%)	Female (%)
21st-Century Skills	78.1	81.6
HOTS	83.9	81.9
Numerical Literacy	81.2	85.3

Table 6 shows that the activities carried out by male and female students during the learning process are different. Male students showed higher HOTS activities and involvement than female students. However, in 21st-century skills and numerical literacy skills, the percentage of female students is higher than that of male students. Although there are some differences, both genders show equally good criteria in developing HOTS and numerical literacy during the learning process. The implementation of the 21st-century learning process is also different for each campus. Some public Islamic universities were at a good level: UIN SUKA Yogyakarta (80%), UIN Syarif Hidayatullah Jakarta (80%), UIN SUSKA Riau (80%), UIN Purwokerto (72.5%), UIN IB Padang (80%). Some were at a very good level, such as IAIN Sorong with 88.3%, IAIN Manado with 87.6%, IAIN Batusangkar with 86.6%. IAIN Takengon was at a good level with a score of 80%. So, it can be concluded that the lecturers at nine public Islamic universities have implemented 21st-century skills-based learning very well (81,67%).

Most of public Islamic university students responded very well: UIN SUKA Yogyakarta (81%), UIN Syarif Hidayatullah Jakarta (82.5%), UIN SUSKA Riau (82.9%), UIN Purwokerto (82.6%), IAIN Sorong students (82.8%), IAIN Manado (82%), IAIN Batusangkar (83%), IAIN Takengon (81%). The only one at a good level was UIN IB Padang students with a score of 78.2%. So, it can be concluded that the lecturers at nine public Islamic universities have implemented 21st-century skills-based learning very well, with an average of 81.78%.

Data from research on the relationship between HOTS and numerical literacy in 21st-century learning is summarized in the following table.

Table 7. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	20.357	1.541		13.209	.000
	Numerical Literacy	.225	.059	.253	3.798	.000

a. Dependent Variable: HOTS

Table 7 is the regression analysis output with HOTS (Y) as the dependent variable and numerical literacy (X) as the independent variable. From Table 7, the regression equation can be written as follows.

$$Y = 20.357 + 0.225X$$

From the equation, we can say that students' HOTS will increase by 0.225 if there is an additional 1% of numerical literacy. There is an influence of numerical literacy on HOTS. In addition, based on the R square contained in the summary model, which is 0.064, it means that 6.4% of HOTS is influenced by numerical literacy, while other variables influence the other 93.6%. In this study, it might be influenced by gender factors.

Based on the data analysis and the findings, there are significant differences between female and male students' HOTS and numerical literacy. The HOTS of male students is higher than that of female students, but on the other hand, the numerical literacy skill of female students is higher than that of male students. This study found that males are superior in reasoning, mathematical, and mechanical abilities, and females are superior in correctness, thoroughness, accuracy, and preciseness in thinking, as in the research result by Ansari and Sagita (2021). In line with this, the research results by Shen and Itti (2012) reveal that male students are indeed more focused and are not easily influenced by irrelevant things. Wilkinson and Marrett (2013) also revealed that male students dominate the interaction in the classroom, and most initiate the interaction and control the discussion.

Females' numerical literacy skill is higher than males' because of their strengths in carefully reading problems. In understanding the questions, female students tended to be coherent, detailed, and repetitive when reading the questions. Male and female students are equally capable of understanding information and comprehending problems, according to Rahayuningsih and Jayanti's (2019) findings that female students typically read more reviews than male students, allowing them to recognize more information about the problem than what is revealed in the questions. It is consistent with Carvalho's (2017) assertion that both men and women interpret known elements when receiving information. Male and female students, however, translate information differently, which has an impact on the steps needed to solve difficulties.

Factors influencing this difference include students' skills, intelligence, experience, readiness, and gender. In this study, we discovered that there are disparities between male and female students' approaches to numerical literacy and HOTS test problems. It demonstrates how a person's knowledge affects the decisions they make. According to Amir's (2015) research, a person's knowledge and goal decide what is important to them. The results of this study are consistent with those of Forgasz and Hill's (2013) and Innabi and Dodeen's (2018) studies, which were done in western and middle eastern contexts, respectively. However, they agree with research results from an Asian-focused study by Pang and Seah (2020). The results of this study are in opposition to those of Kashefi et al. (2017) and Thien (2016). Their findings highlight that there is no significant difference between genders.

Inconsistency of findings about gender differences in various contexts due to physical, psychological, heredity, environmental, and cultural variations in the structure of opportunities for students. We cannot deny individual differences. Both males and females each have advantages and disadvantages. Individual differences will create heterogeneity, making it interesting for teachers or lecturers to design learning. Learning that can balance the advantages of each gender. Another thing that can be said is that, in Asia, especially Indonesia, gender equality in learning has been implemented because male and female students have the same rights in learning. However, in this case, there are differences in students' HOT skills and numeric literacy.

CONCLUSION

The study results indicate that the 21st-century competency-based learning process to increase HOTS and numerical literacy of public Islamic university students in Indonesia is very good (81.67%). Students' responses to the learning process are also very good (81.78%). Based on the HOTS and numerical literacy test results, it was concluded that male students' HOTS was higher than female students. On the other hand, the numerical literacy skills of female students were higher than male students who were taught 21st-century skills learning. Gender partially influences and relates to students' HOTS and numerical literacy in nine public Islamic universities in Indonesia with a low correlation.

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