Jurnal Pendidikan Indonesia
Volume 13, Number 4, 2024 pp. 696-706
P-ISSN: 2303-288X E-ISSN: 2541-7207
Open Access: https://doi.org/10.23887/jpiundiksha.v13i4.84051

Improving Higher Order Thinking Skills Through Multidimensional Curriculum Design at the High School Level

Nirmalasari[1*], Dinn Wahyudin[2], Deni Darmawan[3]

[1,2] Department of Curriculum Development, Indonesian Education University

ARTICLE INFO

Article history:
Received August 10, 2024
Accepted December 11, 2024
Available online December 25, 2024

Kata Kunci:
Keterampilan Berpikir Tingkat Tinggi, Kurikulum Multidimensi, Dimensi Keterampilan Berpikir

Keywords:
High-level Thinking Skills, Multidimensional Curriculum, Dimensions Of Thinking Skills

ABSTRAK

Penelitian ini dilatarbelakangi oleh masalah di lapangan yang menunjukkan bahwa kurikulum di sekolah belum optimal mengasah kemampuan berpikir tingkat tinggi siswa. Penelitian ini bertujuan untuk mengetahui efektivitas kurikulum multidimensi dalam meningkatkan keterampilan berpikir tingkat tinggi siswa SMA. Pendekatan yang digunakan dalam penelitian ini adalah pendekatan kuantitatif. Metode yang digunakan adalah quasi eksperimen dengan menguji model kurikulum multidimensi yang terintegrasi dengan kompetensi saintifik, kreatif, dan berpikir masa depan pada kelompok eksperimen dan membandingkannya dengan kelompok kontrol. Partisipan yang dilibatkan adalah 300 siswa SMA yang tersebar di 7 sekolah. Instrumen yang digunakan untuk mengukur keterampilan berpikir siswa adalah angket yang memuat tiga dimensi, yaitu saintifik, kreatif, dan berpikir masa depan. Dimensi berpikir saintifik memuat keterampilan inkuiri, dimensi berpikir kreatif memuat cara-cara memecahkan masalah, dan dimensi berpikir masa depan memuat pandangan individu dan waktu. Hasil penelitian menunjukkan bahwa keterampilan berpikir tingkat tinggi pada kelompok eksperimen mengalami peningkatan lebih signifikan dibandingkan kelompok kontrol. Dimensi kemampuan yang mengalami peningkatan paling signifikan adalah keterampilan berpikir masa depan dan keterampilan berpikir kreatif. Model kurikulum multidimensi harus disertai dengan strategi atau metode pembelajaran yang inovatif dan kreatif yang mendorong keterampilan berpikir tingkat tinggi pada siswa berbagai usia. Implikasi dari penelitian ini adalah model kurikulum multidimensi dapat digunakan pada jenjang sekolah menengah dalam rangka meningkatkan keterampilan berpikir tingkat tinggi.

ABSTRACT

This research is motivated by problems in the field which show that the curriculum in schools has not optimally honed students' high-level thinking abilities. This research aims to determine the effectiveness of a multidimensional curriculum in improving high school students' higher order thinking skills. The approach used in this research is a quantitative approach. The method used is quasi-experimental by testing a multidimensional curriculum model integrated with scientific, creative and future thinking competencies in the experimental group and comparing it with the control group. The participants involved were 300 high school students spread across 7 schools. The instrument used to measure students' thinking skills is a questionnaire that contains three dimensions, namely scientific, creative and future thinking. The scientific thinking dimension contains inquiry skills, the creative thinking dimension contains ways of solving problems, and the future thinking dimension contains individual views and time. The results of the study showed that the high-level thinking skills in the experimental group experienced more significant improvement compared to the control group. The dimensions of ability that experienced the most significant increase were future thinking skills and creative thinking skills. A multidimensional curriculum model must be accompanied by innovative and creative learning strategies or methods that encourage higher order thinking skills in students of various ages. The implication of this research is that the multidimensional curriculum model can be used at the secondary school level in order to improve higher order thinking skills.

*Corresponding author
E-mail addresses: nirmalasari@upi.edu (Nirmalasari)

1. INTRODUCTION

The majority of students in Indonesia still do not have optimal high-level thinking skills. This is proven by several findings and evidence in the field, for example there are still many students who are unable to solve problems that require high level thinking skills. This situation encourages researchers and stakeholders to design curricula and learning processes that encourage students' higher-order thinking abilities. What kind of education is appropriate and best to answer future challenges? This question is of concern to stakeholders both in government and schools themselves (Culver et al., 2019; Menzi Çetin & Akkoyunlu, 2020). The answer lies in curriculum design which must be able to equip students to face future challenges. There are several abilities that students must have in the 21st century, namely critical thinking and problem solving skills, communication skills, collaboration, computing and information technology skills, career planning, cross-cultural, creative and innovative (Chimbunde & Kgari-Masondo, 2018; Eisman et al., 2020). Integrating critical thinking skills and other abilities is still not enough to create a curriculum that is able to provide superior abilities to students. Education must be appropriate to both local and global contexts according to culture, demands and history as well as future demands such as digital skills (Diamond et al., 2020; Kennedy & Yun, 2021). Improving students' thinking abilities can be done with various methods and strategies designed to improve higher order thinking skills integrated with future thinking skills, individual views, concepts. Global understanding, and the ability to predict these problems in the future (Bennison et al., 2020; Bens et al., 2019). These abilities are really needed by students today. The ability to plan for the future must be given to students. This ability usually depends greatly on the age level of the student. The ability to plan the future from various points of view requires the ability to analyze problems and solve them. This multidimensional curriculum is used by researchers to see its role in improving high-level thinking skills by focusing on three aspects, namely scientific thinking (scientific questions), creative thinking (solving problems creatively), and future thinking (individual views and time) (Davis et al., 2023; Fensham, 2023).

The basis for developing a multidimensional curriculum is a constructivist approach which is believed to be able to improve high-level thinking skills and future thinking skills (Colbran & Gilding, 2019; Song, 2022; Tronsmo, 2020). The multidimensional curriculum framework is built on a curriculum model created for gifted children. The multidimensional curriculum model is based on integrated curricula and parallel curricula as well as programs to provide problem-solving skills for the future (Poulton, 2023; Song, 2022). The integrated curriculum focuses on three aspects, namely the content dimension, the problem dimension, and the process and product dimension. The parallel curriculum focuses on interdisciplinary curriculum, involvement of personality aspects, expert practicum. Problem solving programs include competencies and creative problem solving skills that are much needed in the future so that students can adapt to world demands (Lin & Chuang, 2020; Nghia, 2023). Students at school not only learn about the past, but students must also be equipped with the ability to understand and predict possible future choices regarding a problem. Students must be able to actively imagine to survive in an era of very rapid change. If students are equipped with the ability to predict the future, they will use their imagination to see problems with modern paradigms, discover, analyze, explore and produce new views on problems that are appropriate to the present (Roth McDuffie et al., 2018; Wijnen et al., 2020). In order for students to have the ability to think about the future, they must be equipped with a historical overview, equipped with short-term and long-term planning abilities. Students must be encouraged to develop their competencies in three aspects, namely product development, concepts and views.

The learning methods and strategies used in implementing this multidimensional curriculum prioritize high-level thinking skills. The levels of cognitive abilities from Bloom's revised taxonomy are identification, memory, understanding, implementation, analysis, evaluation, and creation (Aydin & Birgili, 2023; Bielik et al., 2022). Higher order thinking skills at this cognitive level are involved in the process of constructing new knowledge. Multidimensional curriculum design must consider various aspects, including content, thinking strategies, evaluation tools, products, and reflection (Bielik et al., 2022; Brown Wilson & Slade, 2020). These aspects focus on three types of thinking skills, namely scientific thinking skills, creative thinking skills, and future thinking skills (Barfod & Bentsen, 2020; Carroll & Harris, 2023). Referring to these three types of thinking skills, important aspects in curriculum design must be implemented based on several criteria, namely the content of the curriculum is interdisciplinary and concepts are understood comprehensively, the thinking process in the curriculum focuses on three types, namely scientific thinking skills through inquiry, creative thinking to identifying and solving problems, and thinking ahead to build new concepts or knowledge (Bovill & Woolmer, 2019; Büscher & Prediger, 2019). The scientific thinking strategy includes several stages, namely formulating problems, obtaining information, presenting results, and drawing conclusions. Creative thinking includes several stages, including determining problems, providing solutions, creating solution selection criteria, planning actions from various points of view. Future thinking includes several stages, namely identifying components, analyzing and classifying, comparing, identifying relationships and processes, organizing, and making predictions (Frank et al., 2019; Green, 2020). The instrument for improving scientific thinking skills is the Thinking Wheel.

The formulation of subject units in a multidimensional curriculum uses several stages, namely introducing content to students, students' mental representations must be formed by teachers through the involvement of content, process and product components, as well as integrating them with personal, global and time perspectives, teachers must provide alternative content choices. by considering suggestions from students, learning procedures must be introduced to students and must actively involve students in deciding things in the learning process (Eren & Çetin, 2018; Gore et al., 2019). Teachers in this curriculum are required to have flexible, open and democratic criteria in the learning process. Planning by actively involving students can increase student motivation and interest. So, the design of learning process tools in this multidimensional curriculum uses a constructivist approach and integration of perspectives with innovative learning instruments and strategies. This design process can improve scientific, creative and future thinking skills (Fang et al., 2019; Green, 2018). Based on the explanation above, this research tries to determine the effectiveness of an intervention program using a multidimensional curriculum design to improve higher order thinking skills. Researchers investigated the results of interventions in experimental groups who studied certain material using three types of thinking processes (scientific, creative, and future thinking) in a multidimensional curriculum. Next, compare it with the learning outcomes of students who studied using conventional methods in the control group. In addition, this research also investigates the results of learning program interventions with multidimensional curriculum design at various school levels and their relationship with student gender. Previous research mostly highlights the design of learning process activities that can improve high-level thinking skills. In contrast to previous studies, this research focuses on curriculum design that can improve high-level thinking abilities. Through this research, researchers seek to determine the contribution of multidimensional curriculum design to students' higher-order thinking abilities, the dimensions of higher-order thinking abilities, and also see whether there is a relationship between aspects of school level and gender. This research provides knowledge about how to improve higher order thinking skills and future thinking skills through curriculum design. Thus, the aim of this research is to determine the effect of multidimensional curriculum program intervention on students' higher-order thinking abilities, and to determine the relationship between school level and student gender with higher-order thinking abilities when receiving a multidimensional curriculum. intervention.

2. METHOD

This research uses a quantitative approach. This research uses a quasi-experimental research method to determine students' thinking abilities as a result of multidimensional curriculum design intervention. Participants in this research were 300 high school students who were divided into two groups, namely the experimental and control groups with the same number and having the same socio-economic status. The experimental group consisted of 150 junior high school students (grades 10-12). The control group consisted of 150 students with the same high school composition (grades 10-12). The experimental group received a learning program intervention using a multidimensional curriculum, while the control group studied using conventional methods. A description of the demographics of the research participants is presented in Table 1.

Table 1. Demographics of Research Participants

		Research	Control	Total
Grade Level	Class 10	50	50	100
	Class 11	50	50	100
	Class 12	50	50	100
	Total	150	150	300
Gender	Man	150	150	300
	Woman	150	150	300
	Total	300	300	300

The sample was determined proportionally with random clustering to adjust for school level, grade, and gender. Class selection was carried out randomly in each school. Each school randomly selected one class to receive the intervention. Other classes at the same level were also randomly selected for the control group. Class selection has the same ability level, socio-economic level, and represents gender proportionally. The two classes in the intervention and control groups were taught by different teachers. This research was conducted in 7 schools and 20 high school classes grades 10-12 in the Jambi region, Indonesia. The average number of students in one class is 30-40 people. The gender proportion of participants was 150 female students and 150 male students.

This research used several procedures, including the development of an intervention program designed with a multidimensional curriculum. The areas of study that are the focus of intervention are communication skills, economic and globalization skills, culture, understanding internal organs, mathematics. All these areas are studied at school. Each unit contains 10-15 lessons implemented in secondary schools. All areas of study cover scientific, creative and future thinking processes. Future thinking competency focuses on personal and time views of a concept. All universities integrate three types of thinking processes in their implementation process, namely scientific thinking, creative thinking, and future thinking. Scientific thinking uses inquiry, creative thinking uses problem solving steps and theme thinking, future thinking uses mind maps and scenarios or future planning. The control class receives learning using direct or inquiry methods but not too often. Next, the second stage is a pilot study. Assessment instruments and indicators are created based on scales and questionnaire items. This indicator is created based on an agreement between the assessor and the teacher who checks the students' answers to the open questionnaire. The scale used is a scale of 1-5 in each category. The agreement used was 90% so that all teachers assessed the questionnaire results using this indicator. The third stage is testing high-level thinking abilities before and after receiving a learning program intervention with a multidimensional curriculum. In the pretest session, students' thinking abilities were measured by giving open-ended questionnaire answers individually which took around 30 minutes for the pretest and 45 minutes for the posttest. At the end of the lesson, assessments are carried out repeatedly using the same procedure to see the consistency of high-level thinking abilities.

The instrument used to assess high-level thinking abilities is a high-level thinking questionnaire. This questionnaire is used to obtain information about students' thinking abilities, not their level of knowledge. The questionnaire consists of several parts. The first part contains general topics that assess students' scientific thinking abilities. The second part assesses creative thinking skills that present information about the possibility of life in outer space and its relationship with earth. The third section assesses future thinking skills covering general topics and encouraging students to provide personal and temporal perspectives. Questionnaires were used in the experimental and control groups both before and after the learning program intervention. Instrument validation was carried out by two experts in the field using content validity and using factor analysis and varimax rotation. Furthermore, the reliability of the instrument was assessed from student responses to the questionnaire with a value of 0.96. The factor analysis assessment obtained three scales according to the focus of thinking competence (scientific, creative and future). The following are the results of the assessment of each competency a) scientific thinking (investigation) competency consisting of 7 items with a Cronbach's alpha value = 0.90, and a total score of 35. Several questionnaire questions assess scientific thinking skills, namely what are the main findings presented in picture? This question tests classification and analysis skills. What can you conclude from this explanation? This question tests the ability to draw conclusions; b) Creative thinking skills test the ability to identify and solve problems which contains 7 items, with a Cronbach's alpha = 0.93 and a total score of 35. Some of the questions used in this part of the questionnaire are "Identify the problems you found in the data? (problem identification skills), Create alternative solutions for at least five alternative problem solutions that you determine! (ability to provide solutions); time perspective consists of 5 items, with a value of 0.86 and a total score of 25. An example of a question in this section is Create a paragraph containing your personal view on the subject matter presented (this task can position yourself in the first person). Second, time perspective consists of 5 items with a Cronbach's alpha = 0.83 and a total score of 25. An example of a question in this section is How do you think the problem, problem/subject has developed? (ability to describe the process).

Data analysis

From the results of the trial analysis, factor analysis of 500 student responses via questionnaires resulted in one item being deleted, one item being repeated, and two items being integrated. Furthermore, from the results of the questionnaire instrument data analysis, a Cronbach's alpha reliability value of 0.95 was obtained, which explains the three dimensions of high-level thinking skills. The following is an explanation of the results of the analysis of the three dimensions of high-level thinking competence: a) scientific thinking contains 7 questions with a Cronbach's alpha value = 0.86, b) creative thinking competence contains 7 questions with a Cronbach's alpha value = 0.92, and c) thinking competence The future contains 8 items with a Cronbach's alpha value = 0.90. Students' thinking abilities are calculated using scales and items from factor analysis with a score range of 0-5 points and the maximum score for all questionnaire items is 100. Indicators are developed based on the assessor's agreement and processed by multiplying the percentages. the agreed statement is 100. Random sample reliability has a reliability value of 90%. Next, Pearson correlation analysis was used to determine the relationship between dimensions of thinking process competence. Higher order thinking ability scores are calculated separately as a general score and a score for each dimension. The differences between the two groups in the pretest and posttest were calculated using a paired sample test. Differences in variables by group, school level, gender, pretest-posttest, and separate dimension scores were calculated using repeated measures analysis. Participants involved in this research had their parents' consent asked, so that all participants in the research were involved voluntarily without any coercion. Additionally, all participants in the study were anonymous. The research data on students' higher-order thinking abilities in this study was not used for academic purposes at school, but was only used for learning purposes.

3. RESULTS AND DISCUSSION

Results

General higher order thinking abilities

To answer the first problem formulation, the researcher presented data on the influence of learning program interventions using a multidimensional curriculum on increasing higher-level thinking abilities. Based on the results of the analysis, this intervention program had a significant influence on the high-level thinking abilities of students in the experimental group, so that there were differences between the two groups in the pretest and posttest phases. In the pretest phase, in general, the two groups (experimental and control) showed relatively similar thinking abilities or were not much different. Based on the analysis results, the average value and standard deviation of the experimental group are quite significant. From both the pretest and posttest stages, significant differences in scores were found in each group. Furthermore, the main effect of the multidimensional curriculum intervention was found in the experimental group with a value (F[1,188] = 653.46, p<0.001, Effect Size = 0.967). This value shows that the experimental group experienced better improvement than the control group in the pretest and posttest phases. Furthermore, based on the results of multivariate analysis, a significant difference was found between the two groups in terms of value (F[1,547] = 868.67, p<.001, ES = .956). This value shows that the difference in increasing high-level thinking abilities in the experimental group and the control group is around 45%. Comparative data on the high-level thinking skills scores of the experimental and control groups in each phase are presented in Table 2. For further clarity, a multivariate test analysis was carried out based on gender and school level.

Table 2. Higher Order Thinking Skills of Both Groups in The Pretest and Posttest Phases.

	Rat-rat pra-tes (SD)	**Post-test mean (SD)**	**MD**	**T**	**F(df = 1,462)**	**Size effect**
Intervention group (n = 150)	24.42 (17.81)	65.21 (23.35)	-51.45	-31.88	868.67	0.967
Group Control (n = 150)	20.21 (16.67)	33,78 (17,45)	-5.32	-7.56		

p < 0,001.

Next, to answer the second problem formulation, a multivariate test analysis was carried out based on time and gender variables to determine the differences between the two groups. Based on the results of the analysis, the main effect value was obtained based on the gender variable, F value and effect size for male students, namely F [1,188] = 325.76, p < 0.001, ES = 0.852). This value shows that male students in the experimental group have different average scores in each phase. Based on the results of the analysis, the average score for men at the posttest stage was greater than at the pretest stage (24.52 [20.78] <62.78 [22.52]) and the average score for the control group at the posttest stage was greater than at the posttest stage. pretest, but not very significant and the control group (21.62 [14.62] <25.21 [16.85]). Furthermore, the main effect value was found for female students (F[1,189] = 492.78, p < .001, ES = .967). In addition, it was found that the intervention group of female students was superior to the control group sequentially in each phase with a score of (23.21 [16.82] < 66.45 [17.42) and the control group (18.54 [14.47] < 22.61 [17.53). From the results of the analysis it can be concluded that female students have better higher order thinking abilities in the experimental group. This is different from the control group which showed the opposite. The results of data analysis for the experimental and control groups based on phase and gender are presented in Table 3.

Table 3. Higher Order Thinking Skills of Both Groups Based on Student Phase and Gender

	Intervention group			Control group				
	Mean (SD)			Mean (SD)				
	Pray you	**Post test**	**MD**	**Pray you**	**Post test**	**MD**	**F (df = 3)**	**Size effect**
Male (n = 250)	24.52 (20.78)	62,78 (22,52)	-38.72**	21.62 (14.62)	25.21 (16.85)	-6.51**	325.76**	0,852
Daughters (n = 250)	23.21 (16.82)	66,45 (17,42)	42.31**	18.54 (14.47)	22.61 (17.53)	-5.62**	492,78**	0,967

__p < 0,001.

Furthermore, still answering the second problem formulation, an analysis of higher thinking abilities was carried out based on school level. Based on the results of the analysis, quite significant differences were found. To find out more, data on the average score (standard deviation), F value and effect size are presented. Differences were found in the experimental and control groups based on secondary school level. From the results of the analysis it is known that the curriculum has a significant main effect at the 10th and 11th grade school level with grades (F[3,230] = 482.21, p<0.001, SE = 0.862). Furthermore, the average score and the average difference value of the experimental group at the posttest stage experienced a significant increase with a value of (21.42 [18.76] < 62.65 [21.53], MD = -43.51, p < 0.001), different from the control group, the score on the control group also showed an increase in the posttest stage, but it was not significant with a score (17.35 [13.45] < 21.35 [16.72], MD = -4.91, p < 0.001). Furthermore, at the secondary school level, the multidimensional curriculum provided a significant effect size with grades (F[3,230] = 316.31, p < .001, SE = 0.834). Apart from that, the mean value and significant mean difference were also found in the experimental group at the pretest and posttest stages with a value of (33.82 [7.56] < 65.45 [7.31], MD = -36.76, p < .001). The control group also experienced an increase, but not significantly compared to the experimental group (35.32 [7.5] < 45.35 [7.12], MD = -6.14, p < .001). From the results of the analysis, the high-level thinking abilities of high school students experienced a more significant increase compared to students in grades 10 and 11 in both the experimental and control groups. The experimental group of students in grades 10 and 11 at the pretest stage had lower initial abilities than high school students, but their improvement at the posttest stage was greater than that of high school students. At the posttest stage, students in grades 10 and 11 almost had the same thinking abilities as high school students. The results of the analysis of high-level thinking abilities based on school level are presented in Table 4.

Table 4. Results of Analysis of Higher Order Thinking Abilities Based on School Level

	Intervention group			Control group				
	Pray you	**Post test**	**MD**	**Pray you**	**Post test**	**MD**	**F (df = 3)**	**Size effect**
Grades 10 and 11	21.42 (18.76)	62,65 (21,53)	-43.51**	17.35 (13.45)	21.35 (16.72)	-4.91**	482.21**	0.862
Class 12	33,82 (7,56)	65.45 (7.31)	-36.76 **	35.32 (7.5)	42.35 (7.12)	-6.14**	316.31**	0.834

**p < 0,001.

Table 5. Relationship Between Dimensions of Higher Order Thinking Abilities and Curriculum Dimensions

	Scientific thinking	**Think creatively**	**Future thinking**
Scientific thinking	______	0.692**	0.561**
Think creatively	______	______	0.845**

**p < 0,001.

Based on the results of the correlation test in Table 5, it was found that there was a significant correlation between the three dimensions of thinking competency contained in the multidimensional curriculum design. The strongest correlation is found in the correlation between creative thinking (identifying and solving problems) and future thinking (personal and time perspective) with a value of 0.845. This is followed by the second correlation, namely the relationship between scientific thinking (inquiry) and creative thinking (identifying and solving problems) with a value of 0.692 and finally the relationship between scientific thinking (inquiry) and future thinking (personal and time perspective). with a value of 0.561. So, it can be concluded that the Pearson correlation between dimensions of thinking competence in a multidimensional curriculum provides a significant main effect. From these data it can be interpreted that creative thinking skills have a stronger relationship with future thinking compared to scientific thinking.

Researchers conducted a more detailed analysis of each dimension of the multidimensional curriculum to find out more about the role of each dimension in students' higher-order thinking abilities. Based on the results of the analysis, the main influence of each dimension was found, as follows. The main effect of scientific thinking ability ($F[3,521] = 235.652$, $p < .001$, $SE = 0.914$), creative thinking ability ($F[3,624] = 278.241$, $p < .001$, $SE = 0.876$), general future thinking ability ($F[3,521] = 194.521$, $p < 0.001$, $SE = 0.862$) and based on personal perspective ($F[3,521] = 135.641$, $p < .001$, $SE = 0.751$), and time perspective ($F[3,521] = 193.351$, $p < .001$, $SE = 0.842$). Next, each dimension is analyzed based on group, school level and gender variables which will be presented in Table 6.

Table 6. High-level Thinking Abilities for Each Dimension of Thinking Competence

		Intervention group			Control group				
		Pray you	**Post test**	**MD**	**Pray you**	**Post test**	**MD**	**F (df = 3)**	**Size effect**
Scientific thinking	Request (30p.)	9.52 (7.68)	18.46 (8.76)	-9.31**	9.42 (6.79)	11.34 (7.41)	-1.82**	192.21**	0,691
Think creatively	Solution to problem (30p.)	7.67 (6.32)	27.68 (8.12)	-18.24**	7.81 (6.16)	6.78 (6.31)	-0,31	482.35**	0,893
Future thinking	Private P. (20p.)	4.83 (5.62)	14.22 (5.61)	-9.31**	4.72 (5.82)	6.41 (6.42)	-1.72**	192.73**	0,772
	Time P. (20p.)	4.35 (5.31)	14.24 (7.41)	-11.51**	3,91 (4,72)	4.61 (6.21)	-0,83 **	283.81**	0,860
	Personal & Time P.(40 hal.)	8.72 (8.78)	26.23 (9.31)	-18.24**	5.60 (7.20)	7.72 (8.32)	-2.12**	325.72**	0,872

Based on the analysis results in Table 6, significant differences were found in each dimension of high-level thinking abilities in the experimental group. The increase in high-level thinking abilities in the experimental group in the pretest and posttest phases increased by 9-15%. High-level thinking abilities are very low, but there is a significant increase of around 65% at the posttest stage in all dimensions of high-level thinking abilities. The dimensions of thinking competence that increased in the experimental group were future thinking competence and creative thinking competence. The lowest thinking ability score is the future thinking ability score in a time perspective at the pretest value, but it increases at the posttest stage. The value of the ability to think about the future from a time perspective at the posttest stage is in the medium category. Furthermore, the ability to think scientifically obtained the highest score at the pretest stage and showed significant improvement. This increase was better in the experimental group than in the control group. The increase in higher order thinking abilities in the control group was very small. Apart from that, significant differences were also found in higher order thinking abilities based on school level. However, no significant differences were found in each dimension based on the gender variable.

Discussion

To determine the role of multidimensional curriculum design, a learning intervention program was created using a multidimensional curriculum for the two experimental student groups, while the learning intervention for the control group used conventional methods. In the integrated experimental group intervention, three dimensions of thinking competency were also integrated with a multidimensional curriculum, namely scientific, creative and future thinking competencies. Research findings show that this multidimensional curriculum design can improve high-level thinking abilities of middle school students. This finding is in accordance with the theory that thinking competencies will be more effective if taught in an integrated manner in curriculum design and teaching processes (Dijk et al., 2020; Heron & Palfreyman, 2018). Students will indirectly be trained in their thinking competencies through processes and products that are required by the curriculum. So, the use of an integrated approach, explicit instruments, and teaching implicit thinking competencies in the curriculum has proven to be effective in improving students' higher-order thinking abilities. This multidimensional curriculum is designed by introducing thinking competency evaluation instruments, selecting appropriate content, prioritizing collaboration, integrating with technology, and providing opportunities for students to provide different perspectives (O'Dwyer et al., 2020; Oberauer et al., 2019; Smith et al., 2023). The design of this multidimensional curriculum component is able to improve students' high-level thinking competencies. This research is in accordance with previous research which tested the thinking competency improvement program which was proven to be effective in improving students' academic abilities at school, in contrast to students who did not receive the thinking competency improvement program with relatively poor academic achievement (Lu et al., 2018; Miedijensky et al., 2023). Teaching thinking skills is not enough to only use teaching instruments, but needs to be accompanied by other components. This was done in this research. A multidimensional curriculum designed to improve high-level thinking skills uses various components that are integrated with the curriculum, including thinking topics, thinking wheels, problem solving stages, instructions for writing future plans, and relevant units.

A multidimensional curriculum that integrates three dimensions of thinking (scientific, creative and future thinking) is able to effectively improve high-level thinking competencies in high school experimental groups. The main effect size provided by the multidimensional curriculum as a whole is 0.90. From these findings it can be concluded that secondary school students have potential thinking abilities if they are optimized using appropriate intervention programs (Bovill & Woolmer, 2019; Song, 2022). School grade level students who have high-low level thinking abilities can also improve their thinking abilities by using a multidimensional curriculum design, so that the high-level thinking abilities of grade 10 and 11 school students are almost the same as high school students. level of thinking ability of grade 12 high school students. This increase can be seen both in general thinking competence, as well as in each dimension of scientific, creative and future thinking competence. Teaching thinking competencies such as scientific thinking competency (inquiry), creative thinking (problem solving), future thinking (personal perspective and time) carried out to early age students will really help students get used to continuing to use higher level thinking skills. in every learning process (Green, 2020; Hadianto et al., 2021). From the results of the analysis, the increase in the dimension of scientific thinking ability experienced the least increase from pretest to posttest among other thinking competencies. This is inseparable from the complexity of scientific thinking competencies which require quite long stages. Scientific thinking competency is an inquiry process that contains quite complex stages, starting from determining the problem, formulating a hypothesis, planning an experiment, analyzing the results, and drawing conclusions (Barfod & Bentsen, 2020; Kennedy & Yun, 2021). The difference in the significant increase in each dimension of thinking in the experimental group was caused by other additional aspects used by teachers to increase student motivation, such as the use of innovative learning strategies, interesting topics, student involvement in formulating assessment criteria and materials, and a challenging learning process that encourage students' higher-order thinking abilities (Hadianto et al., 2021; Mulyati & Hadianto, 2019).. Furthermore, an increase in the dimensions of creative thinking can be seen in students' ability to identify and solve problems.

This increase also occurred in students who had never previously been involved in the problem-solving process in class, such as elementary school students who rarely used this method. All students at the secondary school level are able to demonstrate their ability to identify problems and solve them in various fields of study. Students who have very low levels of high-level thinking abilities are able to improve their thinking abilities almost on par with middle school students (Brown Wilson & Slade, 2020; Dijk et al., 2020) This finding was quite surprising for the researchers, as well as providing an illustration that younger students are able to optimize their thinking abilities very quickly if given the right intervention. Furthermore, future thinking competence also increased, but the increase was not very significant in the experimental group when viewed from each dimension of personal perspective and time perspective (Cross, 2023; O'Dwyer et al., 2020). This is because the competence to think about the future in secondary school students is something new and rarely used both at school and in everyday life. This is in accordance with the theory that future thinking contains high-level thinking competencies that require understanding between processes, so it takes longer to master them (Oberauer et al., 2019; Song, 2022). In general, more than 55% of junior high school students are able to use this future thinking ability at the posttest stage. This shows that students can be taught future thinking skills well even though it is difficult if using the right intervention program.

The implications of research on improving higher order thinking skills (HOTS) through multidimensional curriculum design at the Senior High School (SMA) level can have a significant impact on educational development. By integrating a multidimensional-based curriculum, schools can create a richer and more diverse learning environment, thereby encouraging students to think critically, creatively and analytically in solving real problems. This approach also requires educators to increase their competence in designing learning that involves various scientific disciplines, innovative teaching methods, and the use of technology as a supporting tool. In addition, the results of this research can be a basis for educational policy makers in formulating strategies to improve the quality of national education, as well as preparing students to be better prepared to face complex global challenges in the future. It is hoped that the implementation of a multidimensional curriculum will also be able to narrow the skills gap between high school graduates and the needs of the world of work or higher education, thereby creating a more adaptive and competitive generation. The implications of research on improving higher order thinking skills (HOTS) through multidimensional curriculum design at the Senior High School (SMA) level can have a significant impact on educational development. By integrating a multidimensional-based curriculum, schools can create a richer and more diverse learning environment, thereby encouraging students to think critically, creatively and analytically in solving real problems. This approach also requires educators to increase their competence in designing learning that involves various scientific disciplines, innovative teaching methods, and the use of technology as a supporting tool. In addition, the results of this research can be a basis for educational policy makers in formulating strategies to improve the quality of national education, as well as preparing students to be better prepared to face complex global challenges in the future. It is hoped that the implementation of a multidimensional curriculum will also be able to narrow the skills gap between high school graduates and the needs of the world of work or higher education, thereby creating a more adaptive and competitive generation.

4. CONCLUSION

The results of the study showed that high-level thinking skills in the experimental group experienced a more significant increase compared to the control group. A multidimensional curriculum that is integrated with the dimensions of thinking skills can improve high-level thinking abilities of secondary school students in various fields of study. The teaching process using a multidimensional curriculum can facilitate students in acquiring scientific, creative and future thinking skills in a relatively short time. Curriculum designed using multidimensional curriculum design at various learning and school levels has proven to be effective in improving high-level thinking skills, strategies and thought processes that are practiced optimally are able to facilitate middle school students to become students who have excellent thinking competence.

5. REFERENCE

Aydin, U., & Birgili, B. (2023). Assessing Mathematical Higher-Order Thinking Skills: An Analysis Of Turkish University Entrance Examinations. *Educational Assessment*, *28*(3), 190–209. Https://Doi.Org/10.1080/10627197.2023.2202311.

Barfod, K., & Bentsen, P. (2020). Don't Ask How Outdoor Education Can Be Integrated Into The School Curriculum; Ask How The School Curriculum Can Be Taught Outside The Classroom. *Curriculum Perspectives*, *38*(2), 151–156. Https://Doi.Org/10.1007/S41297-018-0055-9.

Bennison, A., Goos, M., & Geiger, V. (2020). Utilising A Research-Informed Instructional Design Approach To Develop An Online Resource To Support Teacher Professional Learning On Embedding Numeracy Across The Curriculum. *ZDM - Mathematics Education*, *52*(5), 1017–1031. Https://Doi.Org/10.1007/S11858-020.

Bens, S., Kolomitro, K., & Han, A. (2019). Curriculum Development: Enabling And Limiting Factors. *International Journal For Academic Development*, *26*(4), 481–485. Https://Doi.Org/10.1080/1360144X.2020.1842744.

Bielik, T., Stephens, L., Mcintyre, C., Damelin, D., & Krajcik, J. S. (2022). Correction To: Supporting Student System Modelling Practice Through Curriculum And Technology Design (Journal Of Science Education And Technology. *Journal Of Science Education And Technology*, *31*, *2*(2), 217–231 , 10 1007 10956–021–09943–. Https://Doi.Org/10.1007/S10956-021-09948-7.

Bovill, C., & Woolmer, C. (2019). How Conceptualisations Of Curriculum In Higher Education Influence Student-Staff Co-Creation In And Of The Curriculum. *Higher Education*, *78*(3), 407–422. Https://Doi.Org/10.1007/S10734-018-0349-8.

Brown Wilson, C., & Slade, C. (2020). From Consultation And Collaboration To Consensus: Introducing An Alternative Model Of Curriculum Development. *International Journal For Academic Development*, *25*(2), 189–194. Https://Doi.Org/10.1080/1360144X.2019.1584897.

Büscher, C., & Prediger, S. (2019). Teachers' Practices Of Integrating Challenging Demands Of Inclusive Mathematics Education In A Professional Development Program. *Journal Of Mathematics Teacher Education*, *0123456789*(3), 87. Https://Doi.Org/10.1007/S10857-022-09560-5.

Carroll, K. A., & Harris, C. M. (2023). Using A Repetitive Instructional Intervention To Improve Students'

Higher-Order Thinking Skills. *College Teaching*, *69*(2), 82–90. Https://Doi.Org/10.1080/87567555.2020.1823310.
Chimbunde, P., & Kgari-Masondo, C. M. (2018). Curriculum Change And Teachers' Representations Of Challenges: The Case Of The Social Studies Curriculum In Zimbabwe. *Curriculum Perspectives*, *41*(1), 35–45. Https://Doi.Org/10.1007/S41297-020-00115-3.
Colbran, S. E., & Gilding, A. (2019). An Authentic Constructionist Approach To Students' Visualisation Of The Law. *Law Teacher*, *53*(1), 1–34. Https://Doi.Org/10.1080/03069400.2018.1496313.
Cross, R. (2023). Correction To: Creative In Finding Creativity In The Curriculum: The CLIL Second Language Classroom (The Australian Educational Researcher. *Australian Educational Researcher*, *39*, *4*(1), 431–445 , 10 1007 13384–012–0074–8. Https://Doi.Org/10.1007/S13384-020-00427-3.
Culver, K. C., Braxton, J., & Pascarella, E. (2019). Does Teaching Rigorously Really Enhance Undergraduates' Intellectual Development? The Relationship Of Academic Rigor With Critical Thinking Skills And Lifelong Learning Motivations. *Higher Education*, *78*(4), 611–627. Https://Doi.Org/10.1007/S10734-019-00361-Z.
Davis, K. A., Grote, D., Mahmoudi, H., Perry, L., Ghaffarzadegan, N., Grohs, J., Hosseinichimeh, N., Knight, D. B., & Triantis, K. (2023). Comparing Self-Report Assessments And Scenario-Based Assessments Of Systems Thinking Competence. *Journal Of Science Education And Technology*, *32*(6), 793–813. Https://Doi.Org/10.1007/S10956-023-10027-2.
Diamond, K., Kandola, S., & Weimerskirch, M. (2020). Developing Problem-Solving Skills In Active Learning Pre-Calculus Courses. *Primus*, *2*(3), 1–16. Https://Doi.Org/10.1080/10511970.2020.1772917.
Dijk, E. E., Geertsema, J., Schaaf, M. F., Tartwijk, J., & Kluijtmans, M. (2020). Connecting Academics' Disciplinary Knowledge To Their Professional Development As University Teachers: A Conceptual Analysis Of Teacher Expertise And Teacher Knowledge. *Higher Education*, *0123456789*(2), 87. Https://Doi.Org/10.1007/S10734-022-00953-2.
Eisman, A. B., Kilbourne, A. M., Greene, D., Walton, M., & Cunningham, R. (2020). The User-Program Interaction: How Teacher Experience Shapes The Relationship Between Intervention Packaging And Fidelity To A State-Adopted Health Curriculum. *Prevention Science*, *21*(6), 820–829. Https://Doi.Org/10.1007/S11121-020-01120-8.
Eren, A., & Çetin, G. (2018). Pre-Service Teachers' Beliefs About The Teaching Profession, Curriculum Orientations, And Personal Responsibility. *Curriculum Perspectives*, *39*(1), 19–32. Https://Doi.Org/10.1007/S41297-018-00061-1.
Fang, J. W., Chang, S. C., Hwang, G. J., & Yang, G. (2019). An Online Collaborative Peer-Assessment Approach To Strengthening Pre-Service Teachers' Digital Content Development Competence And Higher-Order Thinking Tendency. *Educational Technology Research And Development*, *69*(2), 1155–1181. Https://Doi.Org/10.1007/S11423-021-09990-7.
Fensham, P. J. (2023). Correction To: The Future Curriculum For School Science: What Can Be Learnt From The Past? (Research In Science Education. *Research In Science Education*, *46*, *2*, *(16*(3), 10 1007 11165–015–9511–9. Https://Doi.Org/10.1007/S11165-022-10076-4.
Frank, J. L., Broderick, P. C., Oh, Y., Mitra, J., Kohler, K., Schussler, D. L., Geier, C., Roeser, R. W., Berrena, E., Mahfouz, J., Levitan, J., & Greenberg, M. T. (2019). The Effectiveness Of A Teacher-Delivered Mindfulness-Based Curriculum On Adolescent Social-Emotional And Executive Functioning. *Mindfulness*, *12*(5), 1234–1251. Https://Doi.Org/10.1007/S12671-021-01594-9.
Gore, J., Banks, A. P., & Mcdowall, A. (2019). Developing Cognitive Task Analysis And The Importance Of Socio-Cognitive Competence/Insight For Professional Practice. *Cognition, Technology And Work*, *20*(4), 555–563. Https://Doi.Org/10.1007/S10111-018-0502-2.
Green, B. (2018). Understanding Curriculum As Practice, Or On The Practice Turn(S) In Curriculum Inquiry. *Curriculum Perspectives*, *42*(1), 77–83. Https://Doi.Org/10.1007/S41297-022-00160-0.
Green, B. (2020). Understanding Curriculum? Notes Towards A Conceptual Basis For Curriculum Inquiry. *Curriculum Perspectives*, *38*(1), 81–84. Https://Doi.Org/10.1007/S41297-017-0038-2.
Hadianto, D., Damaianti, S., V., M., Y., & Sastromiharjo, A. (2021). Effectiveness Of Literacy Teaching Design Integrating Local Culture Discourse And Activities To Enhance Reading Skills. *Cogent Education*, *9*(1), 34. Https://Doi.Org/10.1080/2331186X.2021.2016040.
Heron, M., & Palfreyman, D. M. (2018). Exploring Higher-Order Thinking In Higher Education Seminar Talk. *College Teaching*, *71*(4), 252–259. Https://Doi.Org/10.1080/87567555.2021.2018397.
Kennedy, W., & Yun, J. (2021). Universal Design For Learning As A Curriculum Development Tool In Physical Education. *Journal Of Physical Education, Recreation And Dance*, *90*(6), 25–31. Https://Doi.Org/10.1080/07303084.2019.1614119.
Lin, C. T., & Chuang, S. S. (2020). The Role Of Empathy Between Functional Competence Diversity And Competence Acquisition: A Case Study Of Interdisciplinary Teams. *Quality And Quantity*, *52*(6),

2535–2556. Https://Doi.Org/10.1007/S11135-018-0794-6.

Lu, K., Pang, F., & Shadiev, R. (2018). Understanding The Mediating Effect Of Learning Approach Between Learning Factors And Higher Order Thinking Skills In Collaborative Inquiry-Based Learning. *Educational Technology Research And Development*, *69*(5), 2475–2492. Https://Doi.Org/10.1007/S11423-021-10025-4.

Menzi Çetin, N., & Akkoyunlu, B. (2020). Integrating Scientific Communication Into Middle School Lessons: A Curriculum Design Research. *Education And Information Technologies*, *25*(4), 2371–2391. Https://Doi.Org/10.1007/S10639-020-10208-1.

Miedijensky, S., Sasson, I., & Yehuda, I. (2023). Teachers' Learning Communities For Developing High Order Thinking Skills—A Case Study Of A School Pedagogical Change. *Interchange*, *52*(4), 577–598. Https://Doi.Org/10.1007/S10780-021-09423-7.

Mulyati, Y., & Hadianto, D. (2019). Relation Between Behavioural Problems And Reading Skills In Gender Contexts: Forecasting Longitudinal Data From Kindergarten To Fifth Grade. *Journal Of Educational And Social Research*, *12*(4), 120–130. Https://Doi.Org/10.36941/Jesr-2022-0101.

Nghia, T. L. H. (2023). Vietnamese Students' Learning Motivations For Master's Programmes: Implications For Curriculum Development And Pedagogical Practice. *Journal Of Further And Higher Education*, *43*(8), 1021–1037. Https://Doi.Org/10.1080/0309877X.2018.1444742.

O'Dwyer, A., Hourigan, M., Leavy, A. M., & Corry, E. (2020). I Have Seen STEM In Action And It's Quite Do-Able!" The Impact Of An Extended Professional Development Model On Teacher Efficacy In Primary STEM Education. *International Journal Of Science And Mathematics Education*, *21*(7), 131–157. Https://Doi.Org/10.1007/S10763-023-10361-2.

Oberauer, K., Schickl, M., Zint, M., Liebhaber, N., Deisenrieder, V., Kubisch, S., Parth, S., Frick, M., Stötter, H., & Keller, L. (2019). The Impact Of Teenagers' Emotions On Their Complexity Thinking Competence Related To Climate Change And Its Consequences On Their Future: Looking At Complex Interconnections And Implications In Climate Change Education. *Sustainability Science*, *18*(2), 907–931. Https://Doi.Org/10.1007/S11625-022-01222-Y.

Poulton, P. (2023). Teacher Agency In Curriculum Reform: The Role Of Assessment In Enabling And Constraining Primary Teachers' Agency. *Curriculum Perspectives*, *40*(1), 35–48. Https://Doi.Org/10.1007/S41297-020-00100-W.

Roth Mcduffie, A., Choppin, J., Drake, C., Davis, J. D., & Brown, J. (2018). Middle School Teachers' Differing Perceptions And Use Of Curriculum Materials And The Common Core. *Journal Of Mathematics Teacher Education*, *21*(6), 545–577. Https://Doi.Org/10.1007/S10857-017-9368-0.

Smith, V. T., Gamede, B. T., & Uleanya, C. (2023). Correction To: Subject Advisers. *Perception Of Curriculum Delivery In The Intermediate Phase In South Africa (Interchange*, *50*, *3*(2), 293–303 , 10 1007 10780–019–09359–. Https://Doi.Org/10.1007/S10780-019-09376-Y.

Song, M. J. (2022). The Application Of Digital Fabrication Technologies To The Art And Design Curriculum In A Teacher Preparation Program: A Case Study. *International Journal Of Technology And Design Education*, *30*(4), 687–707. Https://Doi.Org/10.1007/S10798-019-09524-6.

Tronsmo, E. (2020). Investigating Teachers' Work With Multiple Knowledge Resources In Local Curriculum Development. *Pedagogy, Culture And Society*, *27*(4), 555–574. Https://Doi.Org/10.1080/14681366.2018.

Wijnen, F., Molen, J., & Voogt, J. (2020). Primary School Teachers' Attitudes Toward Technology Use And Stimulating Higher-Order Thinking In Students: A Review Of The Literature. *Journal Of Research On Technology In Education*, *55*(4), 545–567. Https://Doi.Org/10.1080/15391523.2021.1991864.