Research Article https://doi.org/10.12973/ijem.8.2.231

International Journal of Educational Methodology
Volume 8, Issue 2, 231 - 240.

ISSN: 2469-9632
http://www.ijem.com/

Evaluation of the Curriculum of Junior High School Mathematics Subject Using Spatial Analysis in the Regions of Pekanbaru

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Received: January 19, 2022 ▪ Revised: March 2, 2022 ▪ Accepted: April 26, 2022

Abstract: Evaluation of the K-13 curriculum (2013 Curriculum) on the value of the national mathematics examination “Nilai Ebtanas Murni” (NEM) in every State Junior High School needs to be carried out thoroughly in order to improve the quality of education. This study uses spatial analysis to evaluate the curriculum and determine the development of NEM scores in the school year. Furthermore, the kriging interpolation method via surfer software was used to generate scores. The results showed that the 2015 K-13 mathematics curriculum did not give good results based on the 36-68 NEM score interval for the entire Pekanbaru area. In addition, the curriculum only gives good results for a small area in the north and south. In 2016, the curriculum which was accompanied by the entry of the new education unit level curriculum “Kurikulum Tingkat Satuan Pendidikan” (KTSP) showed a significant change in the NEM value. Although most of these areas experienced an increase in scores, the intervals still ranged from 36-68. The total revision of the K-13 curriculum carried out and used in 2017 showed a significant increase in scores for all regions with an interval of 68-84 scores. In conclusion, this study shows that the revision of the K-13 curriculum is the right step to produce quality mathematics learning.

Keywords: *Curriculum evaluation, K-13, kriging interpolation, national examination, spatial analysis, surfer software.*

To cite this article: Darwis, A., Yendra, R., & Marizal, M. (2022). Evaluation of the curriculum of junior high school mathematics subject using spatial analysis in the regions of Pekanbaru. *International Journal of Educational Methodology*, *8*(2), 231-240. https://doi.org/10.12973/ijem.8.2.231

Introduction

Curriculum discussion is important to ensure the quality of an educational implementer or school in measuring educational process implementation. The curriculum is defined as a collection of various activities and student learning experiences (Festus & Kurumeh, 2015; Howell & Nolet, 2000). In other words, it is the realization of the overall student experience through school guidance (Syomwene et al., 2013). Also, it was stated that curriculum is the total means of all educational experiences or programs planned for students through guidance (Andrian et al., 2018) to provide direction and purpose for schools in developing learning and assessment. Therefore, efforts for its improvement to achieve successful learning were necessary (Briggs, 2007). Various educational aspects, especially the curriculum as a fundamental feature, need to be evaluated. This evaluation is a process carried out before development, design, and after program implementation. Hence, it has a central role but is interactive with other components and planning stages.

Learning outcomes can be achieved by evaluating the curriculum by building communication between students, teachers and staff. Therefore, it is concluded that it is something that schools must do to describe weaknesses during the educational process (Salim Saif Al-Jardani, 2012). This is a benchmark that the school's goals have been achieved (Gilbert, 2004). In addition, the analysis and identification of the educational process requires evaluation (Lie et al., 2009). This was carried out to analyze and improve the success of students' skills, general achievement, and interpersonal relationships (Curtis & Norgate, 2007). It also emphasized the important things to improve in curriculum development, including student satisfaction in learning, as well as learning outcomes and methods (Zedda et al., 2017). Furthermore, curriculum evaluation aligned the school's mission with general educational goals (Heimlich, 2010). This activity was a guide for teachers to achieve the teaching process (Jacob & Lefgren, 2008). It was also carried out on

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various subjects at the school level, in addition to seeing the suitability of the curriculum used or the development of the lessons. Mathematics is one of the school subjects, hence, it was influenced by a good curriculum. It was important to evaluate its curriculum on an ongoing basis (Baki, 2008). Furthermore, as a subject for every educational level from elementary to college, it will always change according to the development of science and technology (Baykul, 2012). Curriculum planning and development using various models also required evaluation to determine which method suits the conditions of a particular area (Festus & Kurumeh, 2015). However, most of the curriculum evaluations carried out were limited to a few schools. This was appropriate for a country with a small population and area. Meanwhile, for a country with a large population or area and a variety of different cultures, such as Indonesia, the local curriculum played an important role in the region's educational progress. Therefore, it is important to evaluate the curriculum as a whole by maintaining the uniqueness of culture in each region. Cultural heritage needs to be preserved along with the development of information technology by the government and supported by the community (Gavareshki et al., 2012). Culture and diversity are things that need to be preserved so that they can be passed on to the next generation (Hall, 2005). Therefore, the parties who play the most role are government officials and the community. One of the government's roles is to provide a budget for the development of local culture into an attractive object (Środa-Murawska et al., 2017). This is able to grow the economy for the local community (Tubadji, 2012). Students are part of the community that should be involved in preserving local culture (Emin, 2013). Furthermore, this will shape the values and norms of students through social learning activities (Shih et al., 2017). This becomes an effective effort to love regional characteristics and culture (Prastiwi, 2013) through the transformation of goodness values (Strouse & Nickerson, 2016). They are also expected to participate in the preservation of the surrounding culture (Temli Durmuş, 2016). In Indonesia, the national curriculum is given to regions to be implemented and developed in their respective regions (Chan & Wang, 2009). Also, the delegation of authority is an effective means of developing this curriculum. The differences in managing education made it more effective (Papadopoulou & Yirci, 2013). Furthermore, educational decentralization made schools understand and get more familiar with their characteristics or cultural development (Chapman et al., 2002).

The quality of education can be developed by understanding the culture of the region. It is also able to make a character education (Qi, 2011). According to Doherty and Shield (2012) the local curriculum is a factor that increases self-confidence for schools. Innovation can be developed by learning activities for better skills and teacher capacities (Sahasewiyon, 2004). Principals and teachers can enhance their professional competence by curriculum by applying autonomy policies to them. This gives them the opportunity to develop their culture and characteristics through the education system (Mølstad, 2015). The practice of cultural characteristics in teaching activities is practiced by schools that implement this curriculum (Ohansson, 2009). While evaluating the curriculum is an important part in detecting the problems faced by schools (Haghparast et al., 2007). Therefore, an effort to achieve good results is to communicate between students, teachers, and staff, this can be realized by evaluating the curriculum (Harris et al., 2010).

Literature Review

Spatial analysis was used to evaluate the curriculum throughout the schools in a particular region. This study evaluates the K-13 curriculum (2013 Curriculum) which applies to Mathematics subjects for 2015, 2016, and 2017 in Pekanbaru's public junior high schools. Moreover, three maps of national exam scores for mathematics were used to evaluate the success of the curriculum in improving scores for this subject. Several studies on this mapping with various objectives had been carried out. Also, male and female students' competence in understanding mathematics and English subjects was analyzed using spatial analysis. A map of the student population, as well as math and English scores, was generated for the entire region (Murhayati et al., 2019). Furthermore, the mapping of Islamic school students' ability to master mathematics was carried out. The results showed Islamic school students had almost the same abilities as public schools in mastering mathematics (Thamrin et al., 2019).

Critical thinking skills result in students who are more productive, ready and employable in the world of work. Keeping in mind the skills required when students enter the job market, so it is necessary to evaluate the school's internal-based curriculum to a web-based curriculum where students are presented with scenarios involving relevant social issues. It is intended to form critical thinking and problem solving skills (Thompson et al., 2003). Then, many things have been done in evaluating the curriculum starting from the language approach (Zafar, 2011), the skills approach at work (Hemphill et al., 2010) the use of curriculum prototypes (Ubbes et al., 2018) to a comprehensive approach (Pang, 2006).

Meanwhile, the educational environment has a significant role in influencing the achievement of curriculum implementation factors (Villanueva, 2013). Therefore, it is necessary to map each school in determining areas that have a good environmental influence in achieving the educational process. The same was done by Sheringham and Serle (2010) in a project mapping out protocols for the development of curriculum-based human-centred spatial design summaries for next-generation learning environments. Murwantini et al., (2021) have produced research that shows the suitability of the SBC document with the K-13 design, but there are differences in the standards specified, namely the document development component that is not implemented. This means, if the component of developing this document is implemented, there is a possibility that the KTSP curriculum is the same as K-13. Therefore, it is necessary to evaluate the results of student achievement by looking at the NEM scores of each different region.

Methodology

Pekanbaru is the capital of Riau Province. Data of coordinate locations and Mathematics National Examination (NEM) scores for public junior high schools (SMP) for 2015, 2016, and 2017 academic years are shown in Table 1. Meanwhile, Figure 1 shows their location. Also, complete data regarding NEM scores with latitude and longitude locations was obtained through the minister of national education's website.

Table 1. Coordinate, NEM of 2015, 2016 and 2017 for public junior high schools in Pekanbaru

SMP	latitude	longitude	Math 2015	Math 2016	Math 2017
SMP22	0.5018	101.4775	41.98	67.23	75.26
SMP35	0.455618	101.463972	45.15	64.08	75.04
SMP33	0.5197	101.3915	39.04	53.23	74.93
SMP36	0.545451	101.418391	38.75	44.47	68.64
SMP13	0.51454	101.456033	57.35	67.76	79.67
SMP12	0.5301	101.428	42.15	63.99	73.09
SMP18	0.5283	101.428	62.65	68.19	75.94
SMP2	0.532306	101.441968	48.83	63.53	78.03
SMP20	0.486	101.3763	57.45	64.25	77.18
SMP23	0.4886	101.3763	50.84	60.41	74.49
SMP11	0.5355	101.4755	42.41	63.28	76.63
SMP26	0.483	101.5154	39.57	63.5	74.67
SMP31	0.5102	101.525	37.55	51.92	72.63
SMP9	0.4945	101.487	47.87	67.07	77.45
SMP21	0.6472	101.4172	46.7	68.42	76.52
SMP25	0.6035	101.4363	44.77	64.89	75.26
SMP34	0.443569	101.435144	51.98	61.13	75.75
SMP8	0.6538	101.4397	65.18	68.61	81.32
SMP15	0.5729	101.4592	38.78	58.68	75.11
SMP28	0.592361	101.534611	38.9	35.94	69.88
SMP30	0.5624	101.4433	43.25	59.7	77.35
SMP6	0.5725	101.4368	51.88	60.78	78.87
SMP10	0.527155	101.456088	58.13	67.49	82.4
SMP1	0.526383	101.456115	73.86	61.31	86.31
SMP14	0.527155	101.456088	44.01	67.86	78.62
SMP4	0.526383	101.456115	83.12	77.6	85.61
SMP5	0.5271	101.4539	62.23	66.53	82.13
SMP7	0.5361	101.4649	39.18	61.87	76.8
SMP19	0.647404	101.430667	37.73	49.14	76.34
SMP24	0.6062	101.4051	38.87	57.63	73.29
SMP27	0.5471	101.4258	39.10	44.68	67.84
SMP29	0.5896	101.4253	44.77	64.69	75.82
SMP16	0.5278	101.4415	44.00	62.31	73.36
SMP17	0.5086	101.431928	47.32	63.19	75.46
SMP3	0.524157	101.432018	51.96	62.44	78.06
SMP32	0.508592	101.435687	66.37	68.63	80.34

The location of public junior high schools based on the Pekanbaru's latitude and longitude positions was attached in Figure 1. This was used in evaluating the K-13 curriculum based on the results of 3 years of Mathematics learning outcomes.

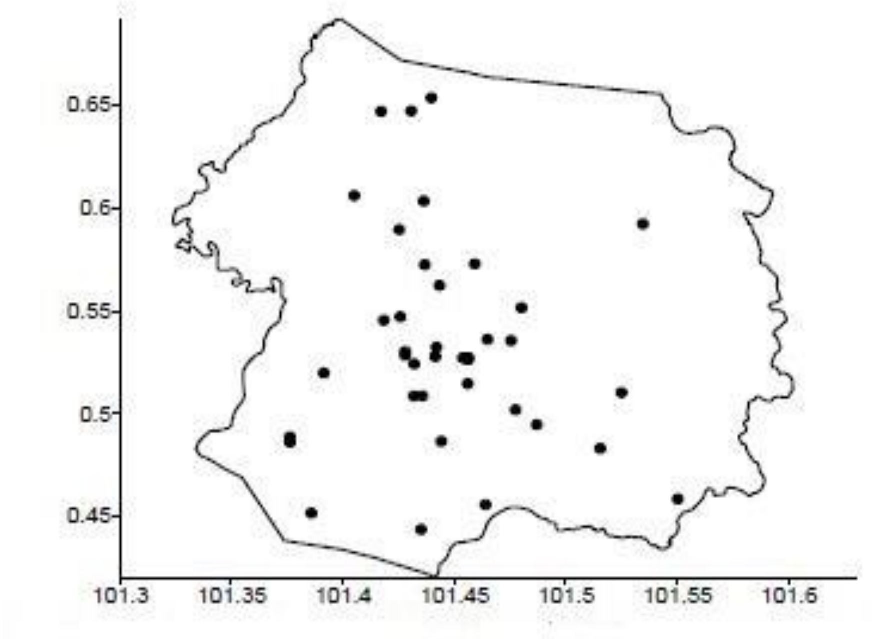

Figure 1. Coordinate Locations of Public Junior High Schools in Pekanbaru

Spatial Analysis and Kriging Interpolation

The spatial analysis used phenomenon data with a location in the form of coordinate points (latitude and longitude). This analysis includes techniques for visualizing phenomena in the form of an area map. Importantly, rainfall, wind speed, and education were recorded in a station or school with latitude and longitude coordinates. The phenomenon needed to be obtained from all coordinate points located in an area, therefore, the interpolation technique to produce the phenomenon value was paramount in the spatial analysis (Fotheringham et al., 2000). There are several methods of interpolating a phenomenon, which include kriging. Some research publications provided complete information about the method (Amri et al., 2016, 2017). This method is used to estimate the value of an interesting variable in an unmeasured location, using data in the environment (Wackernagel, 1994). Furthermore, the calculation process consists of several types, namely Ordinary Block, Ordinary Point, Universal and Co-Kriging (Olea, 1999). Universal Kriging is data with a specific tendency for trends (Kambhammettu et al., 2011). A valuation method used in dealing with the problem of non-stationary data samples might solve difficulties in real life. Some software has provided facilities for interpolation in the form of visual mapping automatically and precisely. For instance, surfer software interpolates and visualizes as area maps. These techniques have been used in several disciplines, such as demography, epidemiology, political science, and sociology. It is not enough to carry out a comparative study of social problems in a large area such as a city or district using an ordinary descriptive study. Therefore, spatial analysis techniques, especially in producing maps of an object (social problems) in an area will be very useful in understanding the region's social problems. In this study, the ability of students who were included in the Islamic education system in the Pekanbaru region to master mathematics was compared with public school students. The resulting map described the differences in each region of the city, as well as the ability of Islamic and public-school students to understand mathematics. These differences can be used by the government to draw the right conclusions which equalize the students' ability to understand the subject in the location. Also, areas where students were known to have weak abilities in the mastery of mathematics were prioritized by providing better teachers or facilities.

Universal Kriging and Semivariogram

In this study, the universal kriging interpolation technique was used to produce all the NEM scores in the Pekanbaru region. This was determined by specifying a general form of semivariogram as in the following equation:

$$\hat{\gamma}(g) = \frac{1}{2Z(g)} \sum_{i-1}^{Z(g)} \left[\left(X(y_i + g) - m(y)\right) - \left(X(y_i) - m(y)\right)\right]^2$$

where

$\hat{\gamma}(g)$: distance g from the experimental semivariogram value

$Z(g)$: number of point pairs within g

$X(y_i + g)$: the value of observations in $y_i + g$

$X(y_i)$: the value of observations in y_i

$m(y)$: trend (drift) equation

Table 2. Models for Estimates Semivariogram

Model mathematics	Model equation
Spherical model	$\gamma(g) = \begin{cases} c\left[\frac{3}{2}\left(\frac{g}{a}\right) - \frac{1}{2}\left(\frac{g}{a}\right)^2\right], g < a \\ c. g \geq a \end{cases}$
Gaussian model	$\gamma(g) = \begin{cases} c\left[1 - exp\left(\frac{-3g^2}{a^2}\right)\right], g < a \\ c, g \geq a \end{cases}$
Exponential model	$\gamma(g) = \begin{cases} c\left[1 - exp\left(\frac{-3g}{a}\right)\right], g < a \\ c, g \geq a \end{cases}$

In general, there were three mathematical models with three variables, namely distance (g), sill (c), and range (a), which determined semivariogram values as shown in Table 2. Before 2004, the completion of the models was very complicated. It became very easy with the provision of mathematical packages in R software, specifically to solve the problems caused by the three equations in Table 2. Also, the software package contained spatial data processing functions (Bivand et al., 2013). Therefore, the GStat R Program was used to analyze the Universal Kriging Method.

Findings / Results

Evaluation of the K-13 curriculum on mathematics learning outcomes in the early stages was carried out by conducting an initial analysis of descriptive statistics based on the data shown in Table 1. According to the Statistical scores in Table 3, implementation of the curriculum in 2015 was poor for generating NEM scores which showed the lowest and highest scores as 37.55 and 83.12 respectively. However, the large score of this variation showed only a small number of schools achieved the highest. Furthermore, the score for that year was low at 49.19, as shown in the average score. In 2016, the implementation of the curriculum for mathematics learning showed an overall increase in grades. This was due to the increase in the average score to 61.41 as shown in Table 3. However, the curriculum did not show maximum results. This can be seen from the decreasing lowest and highest scores. The low variation score of 66.17 compared to the previous year showed some schools almost experienced insignificant NEM scores. Also, there were satisfactory results for the 2017 national exam. The implementation of the revised K-13 curriculum showed a significant increase in NEM scores.

Table 3. Descriptive Statistics of NEM

	Min	1st Qu	Median	Mean	3rd Qu	Max	Var
NEM of Mathematics, 2015	37.55	39.38	45.15	49.19	54.66	83.12	124.9336
NEM of Mathematics, 2016	35.94	60.05	63.28	61.41	66.80	77.60	66.17404
NEM of Mathematics, 2017	67.84	74.80	76.34	76.60	78.34	86.31	16.34691

According to Table 3, the lowest score increased significantly to 67.84 and the highest was 86.31. Overall, public junior high schools in Pekanbaru experienced an increase in the scores, as seen from the average which increased significantly to 76.60. The data variation which was quite small for 16,34691 scores in 2017 indicated that almost all public junior high schools in the region experienced a very significant increase in NEM scores. In conclusion, the descriptive statistical results in Table 3 showed the K-13 curriculum for mathematics was successfully used in 2017 after being revised.

Curriculum evaluation for the regions was also carried out using spatial analysis. This was based on the NEM score map generated for three years (2015, 2016, 2017) of mathematics learning implementation. The evaluation of the K-13 curriculum in 2015 was based on the NEM score map, as shown in Figure 2. Meanwhile, the lowest was marked in red and increased as the green color on the map became brighter. The score of the interval on the map started with the lowest as 36 and the highest above 68. The curriculum implementation for 2015 was not very good because most of the western and eastern parts of the region showed the lowest scores. In other words, the bright red color in most of these regions indicated that there were no satisfactory results. However, a small number of the Northern and Southern regions, marked in green showed good results. The color was also found in a small central part of Pekanbaru, which showed this region had a superior public junior high school.

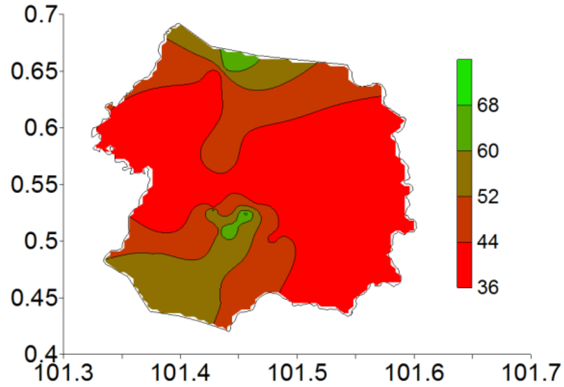

Figure 2. NEM score achievements in 2015 with K-13 curriculum

Evaluation of the K-13 curriculum on the NEM score in the 2016 academic year was also carried out in the Pekanbaru regions. The map of the national exam scores for this lesson is shown in Figure 3. It was shown that the curriculum implementation increased the scores for most regions. Furthermore, the green color dominated more of the North and South regions, while most of the West was dominated by a faded red color which showed there was an insignificant increase in the NEM score for the region. Furthermore, most of the Eastern regions did not succeed in increasing the score. The interval score which was almost the same as the previous year showed K-13 curriculum implemented for mathematics did not fully increase the score in the Pekanbaru regions. This was due to doubts in the application of the new curriculum (KTSP).

The K-13 curriculum for mathematics subjects was revised in 2017. The consequences of this revision are seen based on the NEM score map as shown in Figure 4. Also, there was a significant increase in the scores for almost the entire region. The lowest score of 68 was marked in green color, while the highest which was above 84 was shown in blue. This indicated that there was a significant increase. A small part of the northern and central parts of the city were the regions with the highest NEM score while most of the eastern had the lowest.

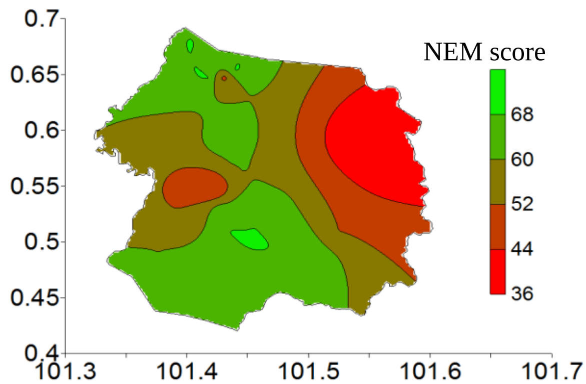

Figure 3. NEM score achievements in 2016 with revised K-13 curriculum

Furthermore, Figure 4 showed implementation of the revised curriculum increased scores for the entire region. An interesting result from the map also showed the regions adjacent to superior schools experienced a significant increase compared to others. This can be seen from the fading blue color which covered almost the entire regions adjacent to the city center.

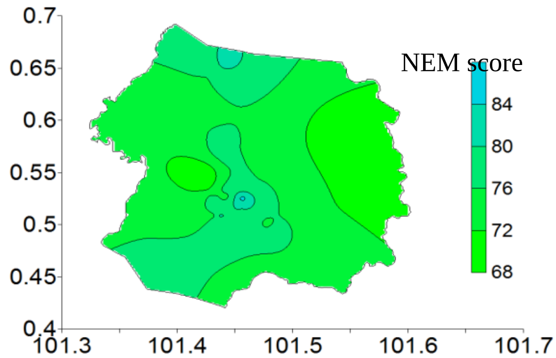

Figure 4. NEM score achievements in 2017 with revised K-13 curriculum

The eastern region of Pekanbaru had lower NEM scores compared to others. Previous studies on the role of gender in mathematics mastery had also produced similar results, that the eastern region had lower scores than the others. Furthermore, it was concluded that the schools in this region were dominated by female students (Murhayati et al., 2019). Another study in Zimbabwe showed schools dominated by females would be very good at mastering English lessons, while those dominated by males would give better math scores (Gasva & Moyo, 2014).

Discussion

These results illustrated that it was important to combine both local and national curriculum. Moreover, this curriculum stimulated the female students' ability to learn mathematics better. It was also shown that the eastern part of the region was inhabited by residents with lower levels of education and income than the others. The role of school-aged children in this region was active in helping parents to find family income. However, this was detrimental to the learners because they lost effective study time. Therefore, this situation illustrated that the curriculum should consider the environmental conditions of students.

Implementation of the curriculum for a wide area takes a long time to achieve the same standards. It can be seen from Figures 2, 3, and 4 that from year to year there is an even distribution. Uniformity in educational facilities is the main factor causing uneven quality of education (Zakaria et al., 2020). In addition to facilities, teachers are also an influential factor in improving students' abilities (Lloyd et al., 2011). So, it becomes natural, the implementation of the new curriculum requires sufficient time to be applied evenly to all regions in Indonesia.

Educational places that are located in residential areas have an influence on the quality of education (Sherringham & Serle, 2010; Sari & Surip, 2020). Learning conditions with a bustling atmosphere make the focus and concentration of students' learning easily disturbed (Kalerante, 2006). Likewise, with teachers, focusing on teaching and paying special attention to curriculum achievements is hampered due to crowded environmental factors (Timor, 2015). This is because teachers often leave school when not on duty in teaching, should spare time when not teaching can be used to prepare better teaching materials. The location of schools that are far from crowds is very helpful in implementing education, which can be seen from Figures 2, 3 and 4 that areas that are far from crowds have the ability to implement the new curriculum faster.

Conclusion

Pekanbaru is a very large area inhabited by people with various tribes and cultures. This makes the local curriculum need attention to improve the learning quality of state junior high school students. A combination of the local and national K-13 made a strong reason to evaluate the overall curriculum in Pekanbaru. Furthermore, the role of spatial analysis as mapping NEM scores for 3 learning years (2015, 2016 and 2017) was used to determine the success of the K-13 on national exam scores. Moreover, the curriculum significantly increased the scores throughout the regions, especially in 2017. This increase occurred after evaluation for the previous 2 academic years. The revision of the curriculum in 2017 managed to improve significantly in a small part of the northern and city center regions. Also, improvements in the central city had a positive effect on the surrounding region. The regional schools that were close to the leading ones showed a significant increase in scores. Therefore, results of the curriculum evaluation showed efforts were still needed in implementing or modifying the revised K-13 curriculum for schools in the eastern part of Pekanbaru.

Recommendations

It is hoped that further researchers will evaluate the curriculum on all subjects tested nationally. Considering that the KTSP curriculum is applied nationally, it is necessary to add research areas to the national level in order to produce more comprehensive conclusions. Then further evaluation can be done by looking at the effectiveness of the KTSP curriculum in all regions in Indonesia. It is necessary to continue with further research on regional evaluations that have implemented the KTSP curriculum well with more comprehensive indicators.

Limitations

This research is limited to the Curriculum of Junior High School Mathematics Subject in the regions of Pekanbaru. These results provide an overview to the government about the influence of the curriculum on students' ability to understand Mathematics learning. Another limitation of this research is that there are no examples in other areas to compare the influence of the curriculum, and there are not enough schools that serve as examples of mapping. Future researchers are expected to improve this research by expanding the topic of discussion, adding samples in other areas to get better results.

Acknowledgements

The authors are grateful to Universitas Islam Negeri Sultan Syarif Kasim, Riau for supporting this study.

Authorship Contribution Statement

Darwis: Conceptualization, design, supervision, material support. Yendra: Editing/reviewing, analysis, final approval. Marizal: Data analysis/interpretation, drafting manuscript, securing funding.

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