Edumatica: Jurnal Pendidikan Matematika
Volume 12 Nomor 02 Agustus 2022

Submited : 01 Januari 2022
Revised : 01 Mei 2022
Accepted : 03 Juni 2022

Pengembangan Perangkat Pembelajaran Berbasis Model Learning Cycle 5E untuk Memfasilitasi Perubahan Konseptual Siswa dalam Pembelajaran Matematika

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Abstrak

Artikel ini bertujuan mendeskripsikan hasil pengembangan perangkat pembelajaran berbasis Learning Cycle 5E pada kriteria valid, praktis, dan efektif untuk memfasilitasi perubahan konseptual siswa pada materi Statistik dan Penyajian Data. Model Four-D digunakan sebagai pendekatan pengembangan penelitian ini. Kualitas produk diukur melalui validitas, kepraktisan, dan efektivitas perangkat pembelajaran. Validitas perangkat diukur dari relevansi dan konsistensinya menggunakan expert judgement. Praktikalitas perangkat diukur menggunakan kuesioner penilaian praktikalitas kepada 5 orang guru Matematika dan 20 orang siswa kelas VIII. Efektifitas diukur melalui ujicoba kelompok kecil dengan melibatkan 1 orang guru Matematika dan 28 orang siswa kelas VIII. Hasil penelitian menunjukkan bahwa perangkat pembelajaran yang dikembangkan memenuhi kriteria validitas, praktikalitas, dan efektivitas. Perangkat pembelajaran dinyatakan valid dengan skor validitas untuk RPP adalah 0.89, lembar aktivitas siswa 0.86, buku guru 0.78, dan buku siswa 0.80. Perangkat pembelajaran dinyatakan praktis dengan skor praktikalitas dimana respons guru adalah 80.31% dengan kategori praktis, dan respons siswa adalah 79.19% dengan kategori praktis. Selanjutnya, perangkat pembelajaran dinyatakan efektif dengan kriteria; rata-rata klasikal hasil belajar siswa mencapai 83.71, tingkat ketuntasan belajar mencapai 82.14%, tingkat pengelolaan pembelajaran guru pada taraf baik, dan keaktifan siswa mencapai 72.5%.

Kata Kunci: *learning cycle 5E, pemahaman konsep, perubahan konseptual*

Development of Learning Cycle 5E-Based Teaching Tools to Facilitate Students' Conceptual Changes in Mathematics Learning

Abstract

This article describes the results of developing Learning Cycle 5E teaching tools that are valid, practical, and effective to facilitate students' conceptual changes in Statistics and Data Presentation material. The Four-D model was used to develop this research. The quality of the product is measured through the validity, practicality, and effectiveness of teaching tools. The device's validity is measured by its relevance and consistency using expert judgment. The device's practicality was measured using a practicality assessment questionnaire, distributed to 5 Mathematics teachers and 20 eighth-grader. Effectiveness was measured through a small group trial involving 1 Mathematics teacher and 28 eighth-grader students. The results showed that the teaching tools developed met the validity, practicality, and effectiveness criteria. Learning tools are declared valid, with the validity score for lesson plans being 0.89, student worksheets being 0.86, teacher book being 0.78, and student book being 0.80. Learning tools are declared practical with a practicality score where the teacher's response is 80.31% in the practical category, and the student's response is 79.19% in the practical category. Furthermore, teaching tools were declared effective with the criteria; the classical average of student learning outcomes reached 83.71, the Learning Completeness Criteria reached 82.14%, the level of teacher learning management was at a Good level, and student activity reached 72.5%.

Keywords: *conceptual change; learning cycle; conceptual understanding*

INTRODUCTION

Although the 2013 curriculum requires student-centered learning, teachers still dominate mathematics learning. The common knowledge of teachers and the lack of access to teaching tools that increase student learning activities are the leading causes of low student learning outcomes in Mathematics. The dominance of teachers in learning Mathematics also hinders students from constructing mathematical understanding through learning experiences. According to a maths teacher, pupils learn mathematics solely through teacher explanations. Teachers struggle to provide instructional activities, media, and tools that enable pupils to develop mathematical comprehension (Aliyyah et al., 2020; E Gradini & Bahri, 2018; Leinhardt, 2019). It should be understood that students do not learn mathematics like 'empty glasses' as in the traditional education perspective. Students' knowledge is developed based on their previous experiences before school. The literature shows that students come into the classroom with an adequate understanding of how and why things behave the way they do (Posner et al., 1982; Resnick, 1983; Strike, 1983). In constructivism, it is believed that students actively build knowledge based on the knowledge they already have as an individual (Amineh & Asl, 2015; Bada & Olusegun, 2015; Cobern, 2012; Stapleton & Stefaniak, 2019; Wilson, 2012). Therefore, as Ausubel emphasized (Ausubel, 1968; Stanley, 2015), what students already know has the most significant influence on their learning. The teacher must ensure this and teach students according to their knowledge. Even if prior knowledge is not necessarily true, this knowledge should not be ignored.

Several constructivist-based modern approaches have been formulated to overcome and restore students' alternative ideas. This approach accepts the broad premise that meaningful learning happens when connections between new knowledge and prior knowledge are actively constructed. Learning is described as the process of facilitating conceptual change by reducing pupils' misunderstandings. The Learning Cycle model, also based on constructivist epistemology, facilitates conceptual change (Boylan, 1988; Dixon, 2017; Laurillard, 2013). In the process, a modified model of the Learning Cycle produces Learning Cycle 3E, 4E, 5E, and 7E models. The Learning Cycle approach was discovered to enhance students' conceptual understanding, attitudes, and misconceptions (Akar, 2005; Balta & Sarac, 2016; Bybee, 2014; Jensen et al., 2015; Khashan, 2016; Konak et al., 2014; Tomkins & Ulus, 2016). The Learning Cycle 5E model is an instructional process that uses activities to enhance student's knowledge, abilities, attitudes, and motivation. Furthermore, students are encouraged to construct their learning techniques through the activities carried out throughout the phase.

Conceptual understanding of mathematics is indicated as the most severe difficulty for students in learning mathematics, both at schools and in colleges (Firmansyah B & Gradini, 2018; Flake et al., 2015; Ega Gradini, 2016; Larkin & Jorgensen, 2016; Oktoviani et al., 2019; Rahmi et al., 2020; Schoenfeld, 2014; Skemp, 2012; Stigler et al., 2010). Therefore, designing teaching tools to facilitate conceptual change in Mathematics learning is very important. The fundamental goals of facilitating meaningful mathematics learning should be to facilitate conceptual development and correct mistakes. One of the fundamental topics is Statistics and Data Presentation. Although many studies have been conducted on students' understanding of concepts in Statistics and Data Presentation (Hadi & Kasum, 2015; I. W. E. Putra et al., 2014; Rahman, 2018), the availability of teaching tools to improve students' conceptual understanding of these topics is still limited. This article describes the results of developing teaching tools based on Learning Cycle 5E on valid, practical, and effective criteria to facilitate students' conceptual changes in Statistics and Data Presentation material.

The term "conceptual change" was first introduced to demonstrate that the ideas incorporated in scientific theories change their meaning when the theory (paradigm) changes (Vosniadou et al., 2015; Vosniadou & Skopeliti, 2014). Conceptual change in learning is defined as a process of a substantial revision of previous knowledge and acquisition of new concepts, usually under systematic learning conditions (Vosniadou et al., 2015). Conceptual change in mathematics can be interpreted as revising students' initial knowledge before learning mathematical concepts into new knowledge (Chow & Treagust, 2013; Liljedahl, 2011; Sniadou, 2013; Vosniadou et al., 2015). Mathematics conceptual change describe as a situation where students' prior mathematical concepts is incompatible with new conceptualization and disposed to make systematic errors or build misconceptions (Merenluoto & Lehtinen, 2004).

Learning Cycle is a learning model that pays attention to students' prior knowledge and then provides opportunities to build their understanding and knowledge of concepts (Duran et al., 2011; Rodriguez et al., 2019). Initially, the 5E Learning Cycle model was applied to science learning such as Physics, Chemistry, and Biology, because this model accommodates laboratory activities. However, many educators are now applying this model in mathematics learning for various purposes. For example, by integrating Learning Cycle 5E and mind mapping (Setiawan et al., 2017); to facilitate mathematical problem-solving skills (Fitriana et al., 2019); measuring concept understanding (Pratiwi, 2016); measuring mathematical communication skills (Agustyaningrum, 2011); and student attitudes (Sriyanti, 2021).

The 5E Learning Cycle Model, which consists of 5 phases; 1) Engagement, 2) Exploration, 3) Explanation, 4) Elaboration, 5) Evaluation, is believed to be able to improve students' understanding of concepts in mathematics learning (Piyayodilokchai et al., 2013; F. Putra et al., 2018; Tuna & Kacar, 2013). Engagement is defined as making connections from past experiences, exposing misunderstandings, and reducing cognitive conflict. Exploration includes activities to develop students' experiences by introducing and discussing new concepts, processes, and skills (Balci et al., 2006). Students are asked to describe their exploration and engagement experiences using standard terms in the explanation stage. Meanwhile, in the elaboration stage, students are involved in new situations that require identical explanations. Learning Cycle 5E ends with an evaluation, where the teacher observes and evaluates each student's knowledge and understanding.

This paper aims to describes the results of developing Learning Cycle 5E model-based teaching tools that are valid, practical, and effective to facilitate students' conceptual changes in Statistics and Data Presentation material. The developed teaching tools quality is measured in terms of its validity, practicality/usability, and effectiveness. The mathematics learning was conducted by implementing five phases of Learning Cycle 5E model. The findings of this study are expected to contribute to teachers providing teaching tools that can facilitate students' conceptual changes in learning Mathematics.

METHOD

The products developed in this research are Learning Cycle 5E -based Mathematics teaching tools which consist of; 1) Lesson Plans, 2) Student worksheets, and 3) teaching materials on the topic of Statistics and Data Presentation. The tool developed aims to facilitate students' conceptual changes in Statistics and Data Presentation material. The Four-D model designed by Thiagarajan, Semmel, and Semmel was used to develop this research. This model has four phases; (1) Define, (2) Design, (3) Develop, and (4) Disseminate (Thiagarajan et al., 1974). The quality of the product developed is measured through the validity, practicality, and effectiveness of teaching tools (Nieveen & Folmer, 2013). The validity of the developed teaching tools is measured by their relevance and consistency using expert judgment (Gregory, 2011). Two experts carried out validation, namely mathematics learning experts and assessment experts. The Expert Agreement Index for content validity analyzes the number of objects from the two experts with the category of strong relevance of the item overall as presented in Table 1, while the validity coefficients are presented in Formula 1 (Gregory, 2011).

Table 1. Assessment of Relevance Categories with Two Validators.

Expert Judgment		**Validator 1**	
		Weak	**Strong**
Validator 2	Weak	A	B
	Strong	C	D

The product has high validity if the validation coefficient is > 0.75, where the expert judgment results are then calculated using the following formula.

 Print ISSN: 2088-2157, Online ISSN: 2580-0779

$$\text{Content validation coefficient} = \frac{D}{(A+B+C+D)} \qquad (1)$$

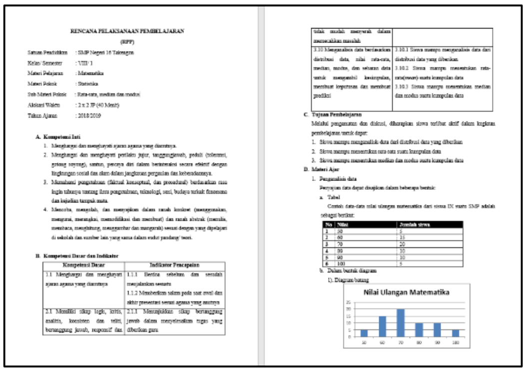
The Learning Cycle 5E-based teaching tool is declared practical if the practicality score exceeds 75%. The device's practicality was measured using a practicality assessment questionnaire to 5 Mathematics teachers and 20 students. The teachers evaluate the practicality of lesson plans, students' worksheets, and teacher's books, while students evaluate the students' books and worksheets. The teacher's questionnaire on product practicality consists of 30 statement items with 4 rating scales. The students' questionnaire consists of 21 statement items with 4 rating scales.

The effectiveness was measured through a small group trial involving 1 Mathematics teacher and 28 eighth grader of a junior high school. The teaching tools developed are declared effective if they meet three of the following four effectiveness criteria (Lukito, 2018). The criteria are; 1) the classical average of student learning outcomes exceeds the Minimum Learning Completeness Criteria (KKM), (2) more than 70% of student activities at a Good level, (3) the level of teacher learning management at a Good level, and (4) more than 75% students exceed the KKM.

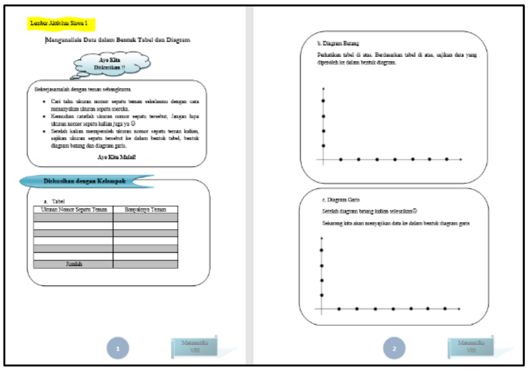
RESULT AND FINDINGS

1. Learning Cycle 5E Teaching Tools (LC5ETT)

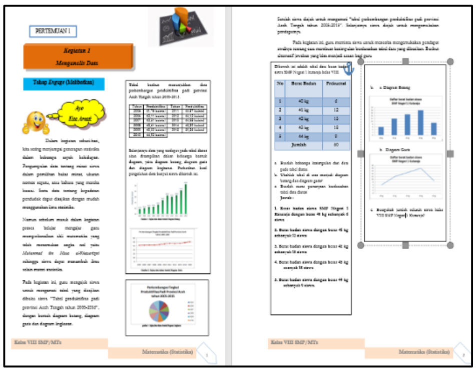
This research produces a conceptual change teaching tool based on Learning Cycle 5E (LC5ETT) in mathematics, consisting of; 1) Lesson plans, 2) Student worksheets, and 3) teaching materials on the topic of Statistics and Data Presentation, namely teachers' book and students' book. The snapshot of the teaching tools is presented on figure 1.



Lesson Plan



Students Worksheet



Teaching Material

Figure 1. The snapshot of the developed product

The teaching tool is based on learning cycle 5E and conceptual change approach. Four-D method (Thiagarajan et al., 1974) deploy to develop the LC5ETT in 4 phases; 1) Define, 2) Design, 3) Develop, and 4) Disseminate. In the definition phase, we determined and defined the needs in the

Learning Cycle 5E model. The definition is conducted through front-end analysis, learner analysis, task analysis, concept analysis, and specifying instructional objectives. LC5ETT is defined on the learning objectives listed in table 2 regarding the results of front-end analysis, students' analysis, assignments analysis, and concept analysis.

Table 2. Specification of Learning Objectives

Basic competencies		Achievement Indicator	
3.10	Analyze data based on data distribution, mean value, median, mode, and data distribution to conclude, make decisions, and make predictions	3.10.1	Students can analyze data from the given data distribution.
		3.10.2	Students can determine the mean of a data set.
		3.10.3	Students can determine the median and mode of a data set.
4.10	Presenting and solving problems related to data distribution, mean, median, mode, and data distribution to conclude, make decisions, and make predictions.	4.10.1	Students can analyze data based on the size of the concentration and spread of data
		4.10.2	Students can observe how to make decisions and make predictions based on analysis and data
		4.10.3	students can present learning outcomes about the size of the concentration and distribution of data and how to make decisions and predictions
		4.10.4	Students can solve problems related to the size of the concentration and distribution of data and make decisions and predictions.

The next stage is the design phase. Wherein this phase, the framework selection, media selection, format selection, and initial design are carried out. Furthermore, modifications and development of the initial design results are carried out at the development phase. At this stage, the development product's validity, practicality, and effectiveness are measured as described below.

a. The Validity of Learning Cycle 5E Teaching Tools (LC5ETT)

Two experts validated lesson plans, students' worksheets, and teaching materials based on Learning Cycle 5E model. The results of expert validation on each product are presented in the following table.

Table 3. The Validity of The Teaching Tools

Teaching tools	Validation Score	Category
Lesson Plan	0.89	Valid
Students' Worksheets	0.86	Valid
Teacher Book	0.78	Valid
Student Book	0.80	Valid

Aspects validated in the lesson plan are completeness of identity, time allocation, formulation of indicators and learning objectives, learning materials, selection of learning approaches, learning activities, selection of learning resources, and assessment techniques. The results of expert validation indicate that the lesson plan based on Learning Cycle 5E is valid with a validation score of 0.89 and indicates the lesson plan has high relevance to the indicators. Despite the lesson plan's high validation, the two experts gave ideas for improvement, including; (1) reducing wordiness so that the lesson plans may be understood more readily by the teacher, and (2) adjustments in the arrangement of the lesson plans to a one-sheet format lesson plan. As a form of enhancement, the final version of the Learning Cycle 5E-based lesson plan contained expert advice.

Aspects validated on the student activity sheet are the suitability of the material, the suitability of the students' worksheets with the didactic requirements, the conformity with the construction requirements, and the conformity of the students' worksheets with the technical requirements. Student activities are ensured to follow the 5E phase of the Learning Cycle. The results of expert validation on the student activity sheet show a validity score of 0.86 and indicate students' worksheets has high relevance to the indicator. There are suggestions for improvement from experts on student activity sheets, namely; (1) the language used is more commutative, and (2) student activities at the engagement stage need to be sharpened. The final version of the student activity sheet has been revised according to the suggestions of the expert validators.

Teaching materials were validated on two products: teacher books and student books based on Learning Cycle 5E model. Both products were validated on the feasibility aspects of construction, illustration, language, material suitability, concept presentation, and mathematical problems according to each phase of the 5E Learning Cycle. Based on the results of expert validation on the product, it was found that the Learning Cycle 5E -based teaching tool had been validly implemented to facilitate students' conceptual changes in Statistics and Data Presentation material. The results of expert validation show that the score for teaching materials validation on the topic of Statistics and Data Presentation based on Learning Cycle 5E is 0.78 for teacher books and 0.80 for student books. Thus, Learning Cycle 5E -based teaching materials are valid for use in Statistics and Data Presentation learning. Some suggestions for improvement given by expert validators include; (1) the mathematical problems presented need to be adjusted to each stage of the 5E Learning Cycle, and (2) the presentation of the material in the engagement phase needs to be strengthened. The final version of Learning Cycle 5E based teaching materials has been improved according to the experts' advice.

b. The practicality of the Learning Cycle 5E Teaching Tools (LC5ETT).

The practicality of teaching tools was measured by distributing practicality questionnaires for each product to 5 Mathematics teachers. In addition, to determine the practicality of the students' worksheets and books, questionnaires were distributed to 20 eighth grader. The results of practicality measurements by teachers are presented in table 4, while the results of practicality measurements by students are shown in table 5.

Table 4. Results of the Teachers Product Practicality Questionnaire

Teaching Tools	Practicality Score	Category
Lesson Plan	85.03%	Very Practical
Students Worksheet	76.91%	Practical
Teacher's Book	79.00%	Practical
Average	80.31%	Practical

Table 4 demonstrated the results of measuring the practicality of product development through questionnaires distributed by teachers. The score of Lesson Plans practicalities of achieving Very Practical category with a score of 85.03%, which indicates the level of usability this product is Excellent. The practicality score on the student activity sheet is in the practical category with a score of 76.91%, which indicates the usability of students' worksheets in learning is good. Likewise, with the quality of the teaching materials developed, the practicality level of teacher books is 79.00% in the practical category. This score indicates that the usability of teaching materials based on Learning Cycle 5E is good.

Table 5. Result of Students' Product Practicality Questionnaire

Learning Media	Practicality Score	Category
Student Worksheets	78.03%	Practical
Student Book	80.35%	Practical
Average	79.19%	Practical

Table 5 presents the results of the practicality questionnaire by students, which shows that the practicality scores of students' worksheets and book are 78.03% and 80.35%, respectively. According to the 8th grader, the two products are in the practical category, where the usability level of the product is already good. This finding is in line with some studies that found worksheet and book is a good facilitator of conceptual changes (Castro, 1998; Chen & Wang, 2016; Koparan & Güven, 2015; Sungur et al., 2001).

c. Effectiveness of The Learning Cycle 5E Teaching Tools (LC5ETT)

The learning of Statistics and Presentation of Data is conducted using valid and practical teaching tools. The learning is conducted for four meetings in 5E phases, namely 1) Engagement, 2)

Exploration, 3) Explanation, 4) Elaboration, and 5) Evaluation. A small group trial involving 1 Mathematics teacher and 28 students was conducted to measure the product's effectiveness. The following are the observation of teacher deploying learning cycle 5E using developed products.

Table 6. Teacher ability in Implementing Learning Cycle 5E

Phase	Score	Category
Engagement	3.91	Excellent
Exploration	3.52	Excellent
Explanation	3.11	Good
Elaboration	3.04	Good
Evaluation	3.35	Good
Average	3.38	Good

In general, the ability of teachers to conduct the learning cycle 5E by deploying the product is 3.38, with a good category. This finding is in line with several studies which have found that the Learning Cycle 5E model can improve teachers' classroom management skills (Akar, 2005; Balta & Sarac, 2016; Goldston et al., 2010; Tomkins & Ulus, 2016). The following describes the results of observing the teacher's ability to manage learning in five phases of the Learning Cycle.

In the engagement phase, the teacher's ability to teach using teaching tools is 3.91, with an excellent category. In the engagement phase, the teacher accesses students' prior knowledge by asking them to share their data presentation experiences. The teacher helps them engage in new concepts through short activities that increase curiosity and acquire prior knowledge. In this phase, the teacher connects past and present learning experiences. This research demonstrates that apperception is accomplished through exposing prior notions and tracing students' reasoning. This finding is in line with Balci, who found that the teacher discovered students' misconceptions in engagement phase (Balci et al., 2006). After the teacher confirms the correctness of the students' initial concepts, the teacher continues in the exploration phase.

In the exploration phase, the teacher's ability to teach using teaching tools is 3.52, with an excellent category. In this phase, the teacher begins to facilitate students' conceptual changes. Facilitation is performed by assigning the same activities to students in which concepts, processes, and skills are identified. The teacher serves as a facilitator, assisting students in generating new ideas, exploring issues and possibilities, designing, and conducting preliminary investigations. After the 'knowledge bridge' is formed, the teacher facilitates students' conceptual changes through the explanation phase.

In the explanation phase, the teacher's ability to teach using Learning Cycle 5E-based teaching tools is 3.11 with a good category. The teacher in this phase provides explanations that focus students' attention on certain aspects. When explaining, the teacher pays attention to the experience and involvement of students by providing opportunities to demonstrate conceptual understanding. Students are directly introduced to a topic, technique, or skill by the teacher to demonstrate their grasp of the concept. During this phase, the teacher helps students with a more profound knowledge after verifying that no misconceptions exist. This point is critical to enter the elaboration phase.

The teacher stimulates and enhances students' conceptual understanding and skills throughout the elaboration phase. Teachers' ability to conduct instruction by utilizing instructional tools based on Learning Cycle 5E is 3.04, with a good category. Teachers provide new experiences related to data presentation through problems experienced around students. Students have a deeper and broader understanding as a result of new experiences. Students also gain additional knowledge and skills.

Furthermore, in the evaluation phase, the teacher's ability to teach using the teaching tools is 3.35 with a good category. In this phase, the teacher assesses students' understanding and ability to see learning objectives. The results of the learning evaluation after using Learning Cycle 5E-based teaching tools are presented in the table 7 and figure 1.

 Print ISSN: 2088-2157, Online ISSN: 2580-0779

Table 7. Student Conceptual Change

	Pre-Implementation	**Post-Implementation**
Minimum Value	45	62.00
Maximum Value	79	95.00
Average Score	61.14	83.71
Mastery learning	7.14%	82.14%

The evaluation results show that the average conceptual understanding of students' after using Learning Cycle 5E-based teaching tools is 83.71, with learning completeness reaching 82.14%. The performance of Learning Cycle 5E -based teaching tools is in line with research findings which found that the Learning Cycle 5E model is adequate for instilling concepts (Akar, 2005; Priyadi et al., 2021; F. Putra et al., 2018), and there is a significant effect and relationship between the Learning Cycle 5E model and student academic achievement (Jack, 2017; Piyayodilokchai et al., 2013; Tuna & Kacar, 2013). Meanwhile, students' activities were also observed during four meetings learning in this phase, as presented in table 8.

Table 8. Student Activities During Learning

Meeting	**Student Activity Level**				**Criteria**
	Not active	**Active Enough**	**Active**	**Very active**	
Meeting 1	20.00%	15.00%	65.00%	0.00%	65% active
Meeting 2	15.00%	20.0%	10.00%	55.00%	65% active
Meeting 3	10.00%	10.00%	60.00%	20.00%	70% active
Meeting 4	10.00%	10.00%	70.00%	10.00%	80% active
Average	13.75%	13.75%	51.25%	21.25%	72.5% active

Student activities during learning tend to be active in every meeting. At the first and second meetings, 65% of students were active, and at the third meeting, student activity increased to 65% and 80% at the fourth meeting. In general, it can be stated that students' activeness is 72.5%. Thus, based on the criteria for measuring effectiveness, it is found that; (1) the average student learning outcomes exceed the minimum criteria, which is 83.71, (2) more than 70% of student activities are at a Good level, (3) the level of teacher ability in conducted teaching is at a Good level, and (4) more than 75% of students exceed the Minimum Criteria Completeness. So that based on the effectiveness testing criteria, Learning Cycle 5E-based teaching tools (LC5ETT) are effectively used to facilitate students' conceptual changes. This finding is supported by numerous studies that found Learning Cycle 5E-based teaching tools effects students' conceptual change in understanding of Photosynthesis and Respiration in Plants (Balci et al., 2006), Genetics (Yilmaz et al., 2011), State of Matter and Solubility Concepts (Ceylan & Geban, 2009), and Number (Carey, 2000).

2. Students Conceptual Change Using Learning Cycle 5E Teaching Tools (LC5ETT)

LC5ETT is used to change students' mathematics concepts by correcting and reducing students' misconceptions. The indicators of conceptual change used are; 1) Scientific Knowledge, 2) Lack of Knowledge, 3) Error, and 4) Misconception (Admoko et al., 2019) as shown at table 9.

Table 9. Conception Categories (Admoko et al., 2019)

Conception Categories	**Students Responses**
Scientific Knowledge	Correct response, scientific explanation, certainty
Lack of Knowledge	Correct response, scientific explanation, uncertainty
	Incorrect response, scientific explanation, uncertainty
	Correct response, unscientific explanation, uncertainty
	Incorrect response, unscientific explanation, uncertainty
Error	Incorrect response, scientific explanation, certainty
Misconception	Correct response, unscientific explanation, certainty
	Incorrect response, unscientific explanation, certainty

This study found a misconception reduction in mathematics learning using LC5ETT. Hence, the students’ concept of mathematics has changed. Students’ conceptual change after the implementation of LS5ETT is presented in table 10.

Table 10. Students’ conception in every category

Concepts	Scientific’ Knowledge		Lack of Knowledge		Error		Misconception	
	Pre-LC5ETT	Post LC5ETT	Pre-LC5ETT	Post LC5ETT	Pre-LC5ETT	Post LC5ETT	Pre-LC5ETT	Post LC5ETT
Data	18.11	53.19	9.12	8.00	11.35	17.42	61.42	21.39
Data Presentation	20.04	64.9	8.30	5.40	27.76	0.70	43.90	29.00
Data Distribution	22.42	43.8	2.40	1.80	22.15	19.60	53.03	34.80
Mean, Median, and Mode	21.90	51.2	8.90	5.00	11.99	13.80	57.21	30.00
Decision and Prediction	11.19	41.00	2.41	2.00	43.12	36.95	43.28	20.05

Table 10 shows that a misconception dominates students' concepts. This finding aligns with a study that found that most students' concepts are misconceptions (Admoko et al., 2019) and more dominant than other concepts (Halim et al., 2021). Table 10 also presents the dynamic of students' concepts, where the misconception decreases when the students' knowledge increases. This finding is supported by numerous studies (Herrmann-Abell & DeBoer, 2011; Milenković et al., 2016; Rebich & Gautier, 2005). Therefore, students construct mathematical concepts through cognitive conflicts which occur in learning.

CONCLUSION

The teaching tools were developed to facilitate students' conceptual changes in Statistics and Data Presentation materials. The teaching tools developed are lesson plans, students’ worksheets, and teaching materials based on the Learning Cycle 5E model. Learning Cycle 5E -based teaching tools are declared valid, with the validity score for lesson plans being 0.89, student activity sheets are 0.86, teacher books are 0.78, and student books are 0.80. Learning Cycle 5E -based teaching tools are declared practical with a practicality score where the teacher's response is 80.31% in the practical category, and the student's response is 79.19% in the practical category. Furthermore, the teaching tools were declared effective with the criteria; the classical average of student learning outcomes reached 83.71, mastery learning reached 85%, teacher’s ability was at a Good level, and student activity reached 72.5%. Thus, it can be concluded that Learning Cycle 5E-based teaching tools are valid, practical, and effectively used to facilitate students' conceptual changes in Statistics and Data Presentation material. The teaching tools also encourage students to construct mathematical concepts through cognitive conflicts which occur in learning. Learning Cycle 5E-based teaching tools are expected to be used by Mathematics teachers in the classroom. Although the research findings show positive results, further trials on a larger group of students are needed for better results. Therefore, the findings of this study can also be used by other researchers to develop it in other materials.

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