Primary Pupils' Attitudes toward Learning Statistical Reasoning using TinkerPlots in Statistical Reasoning Learning Environment (SRLE) Class

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Abstract

Many struggle to make sense of the statistical information provided by articles. In a statistics class, students would be able to use statistical reasoning to analyse and interpret data. The aim of the study is to find out students' attitudes toward learning statistical reasoning using TinkerPlots in the Statistical Reasoning Learning Environment (SRLE) class. The sample of study involved 23 Year Five international primary school students. The participants of this research (experimental group) were chosen using convenience sampling. The students underwent interventions about a month after pre-test. Once intervention was completed, they sat for the post-test. The research was conducted using the Student Attitudes towards Statistics (SATS). Then, the results of questionnaire were analysed using descriptive statistics which were mean and standard deviation. The findings indicated that positive attitude in learning statistics was the response in the questionnaire given by the students. Thus, the study indicates that integrating technology, TinkerPlots in a current learning environment (SRLE class) era develops positive learning attitudes among students and enhances the students' statistical reasoning as well.

Keywords: Statistical reasoning; TinkerPlots; SRLE; Attitudes; Primary mathematics

Introduction

Statistics education is playing an important role in mathematics because the students are exposed to real world situations and have to make decisions wisely based on the interpretation made and be able to reason for the choice. Garfield and Ben-Zvi (2008) claimed that statistics education is also an emerging field that grew out of different disciplines and is currently establishing itself as a unique field of study. The two main disciplines from which statistics education grew are statistics and mathematics education. From then onwards, statistics education has been the focus for researchers in many disciplines, perhaps because statistical reasoning is used in many disciplines and provides so many interesting issues and challenges (Garfield & Ben-Zvi, 2008).

The National Council of Teachers of Mathematics (NCTM), first in *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) and then later in *Principles and Standards for School Mathematics* (NCTM, 2000), emphasized the importance of statistics education as a part of the Data Analysis and Probability content standard (NCTM, 2016). It allows students to formulate questions and collect, organize, as well as display relevant data to answer these questions. Additionally, it emphasizes learning appropriate statistical methods to analyze data, making inferences and predictions based on data, as well as understanding and using the basic concepts of probability (NCTM, 2016).

Seeing the importance of statistical education and statistical reasoning, the purpose of this study was to investigate the attitudes of students' statistical reasoning in a Statistical Reasoning Learning Environment (SRLE) class using the latest technology TinkerPlots software. The research questions are:

1. What is the students' attitude toward learning statistics using *TinkerPlots software*?
2. What is the students' attitude towards learning statistics in Statistical Reasoning Learning Environment (SRLE) class?

Literature Review

Statistical Reasoning

Statistical reasoning involves making interpretations based on sets of data, representations of data, or statistical summaries of data. Much of statistical reasoning combines ideas about data and chance, which leads to making inferences and interpreting statistical results. Underlying this reasoning is a conceptual understanding of important ideas, such as distribution, centre, spread, association, uncertainty, randomness, and sampling (Garfield, 2003). In the past two decades a large number of instruments to measure attitudes and anxiety toward statistics have been developed in order to assess the influence of emotional factor on students (Carmona, 2004). Students often enter an introductory statistics class with less positive attitudes about the subject. They tend to believe statistics is difficult and irrelevant to their lives (Carnell, 2008).

According to Ertug et al. (2014), research was performed in a statistics department, where the phenomenon of negative attitudes toward learning statistics is probably expressed less intensively than in social and behavioural sciences departments. Correspondingly, the National Council of Teachers of Mathematics has recommended that teachers attend to and assess students' attitudes as part of mathematics instruction (NCTM, 1989, 1991). In like manner, attitudes have emerged as primary factors in understanding students' mathematics achievement, their mathematics ability beliefs, and their expectations for success in mathematics (Wigfield & Eccles, 2000).

Learning in a Statistical Reasoning Learning Environment (SRLE) class

Garfield and Ben-Zvi (2007) suggested very different ways of teaching than traditional lectures, which is how most current statistics instructors learned this subject themselves. Leaving that familiar method to try active learning techniques can be quite challenging. Based on the issues above, the research investigated students' attitudes toward learning statistical reasoning using TinkerPlots in a Statistical Reasoning Learning Environment (SRLE) class.

A few major changes differentiate between a "traditional" statistics class and Statistical Reasoning Learning Environment (SRLE) class (Garfield & Ben-Zvi, 2008). First, focus of course in a traditional statistics class concentrates on skills and procedures, covering content.

However, the SRLE class involves big ideas, developing statistical reasoning and thinking. Second, the role of textbook, where the traditional method uses examples or homework problems and to review for test as well as the SRLE focus is reading and taking notes to prepare for class. Third, the traditional class is teacher centred but the SRLE is student centred. The role of teacher in the traditional method is to deliver knowledge by telling and explaining. However, in the SRLE, the teachers facilitate knowledge development through discussion and activities. It is followed by the role of technology, where technology in the traditional class is to compute or check answers, construct graphs but in SRLE class technology is used to explore data, illustrate concepts, generate simulations, test conjectures, and collaborate (Garfield & Ben-Zvi, 2008).

Discourse in the traditional class is where the teachers answer questions whereas in the SRLE class the teacher poses questions and guides a discussion while students present arguments. Students answer other students' questions and are asked if they agree or disagree with the answers. Peer and instructor feedback as well as data are emphasised. In the traditional method, small data sets are used to illustrate and practise procedures. On the other hand, in SRLE class, rich, real data sets are used to engage students in thinking as well as reasoning and making conjectures. Many data sets are generated by the students from surveys and experiments. Finally, assessment given in the traditional method focuses on computations, definitions, and formulas. It also focuses on short answer and multiple-choice tests. Often only a midterm and final tests are given. In contrast, the SRLE class uses a variety of methods to assess reasoning and thinking. Formal and informal assessment is an integral part of learning as well as is aligned with learning methods and goals. Students may be asked to explain their reasoning and justify their conclusions (Garfield & Ben-Zvi, 2008).

A few research support why it is essential to follow the criteria of SRLE class. Bakker (2004) suggested that asking students to make conjectures about possible samples of data pushes them to use conceptual tools to predict the distributions, which helps them develop reasoning about samples. In these processes, "what-if" questions prove to be particularly stimulating. Furthermore, standards in mathematical education have largely emphasised the importance of being engaged in inquiry-based learning. Inquiry is the process whereby students solve problems, pose questions, construct solutions and explain their reasoning (NCTM, 2000; OECD, 2019). One obvious way to bring students into the inquiry learning process is by offering them environments and tasks that allow them to carry out the processes as well as help them build a personal knowledge they can use and explain what they learn. Rapid advances in computer-based learning have facilitated opportunities to empower inquiry learning (Ben-Zvi, Gil, & Apel, 2009).

Use of TinkerPlots in Developing Statistical Reasoning

TinkerPlots software is chosen for several reasons. TinkerPlots is a data analysis tool with simulation capabilities (since version 2.0) that has especially been designed for supporting young students' development of statistical reasoning (Grade 4 of primary school to middle-school students, students from the age of 9 onwards) (Biehler et al., 2017). A study carried out by Ben-Zvi et al. (2009) was one that had left a positive impact concerning utilisation of information technology in developing students' statistical reasoning ability. The study was carried out on primary five graders to increase their informal ideas of inference and argumentative skills using the TinkerPlots software. Results showed that the TinkerPlots software can support students' multiplicative reasoning, aggregate reasoning, recognition of the value of large samples, and variability justification.

In statistics education, it is important to reason and interpret data information using digital technology. For this to happen, the understanding of the underlying statistical models and TinkerPlots techniques are required (Manor & Ben-Zvi, 2017). Digital tools such as TinkerPlots develops students' conceptual understanding of probability and statistics by providing opportunities for the learners to explore the data with appropriate techniques Garfield, delMas, & Zieffler (2012) In addition, the visualization and reasoning of statistical concepts such as random behaviour could be done now (Pfannkuch et al., 2018). Such examples of these digital tools, e.g., TinkerPlots provide opportunities for statistical reasoning with data of learners' ability to construct statistical models (Biehler et al., 2017). The statistical modelling processes would enable students to distinguish the model in the digital environment of TinkerPlots and the real-life models with reasoning (Patel & Pfannkuch, 2018). Furthermore, statistical modelling procedures using TinkerPlots necessitate a comprehension of the concepts involved in addition to the creation of TinkerPlots techniques(van Dijke-Droogers, Drijvers & Bakker, 2021).

Methodology

This study employs one-group posttest only research design with data analysis using descriptive statistics.

Instrumentation

An instrument used in this study was the Students Attitudes towards Statistics (SATS) as attached in the Appendix 1. SATS for the study was adapted from Fennema and Sherman (1976) and adjusted based on the students' attitudes toward learning data handling using *TinkerPlots software*. There are 5 levels of satisfaction on a Likert Scale which are 'Strongly Agree (SA), Agree (A), Undefined (U), Disagree (D) and Strongly Disagree (SD)'. The questionnaire was given to find out students' attitudes in learning data handling using *TinkerPlots software*. The research question was answered from Item 1 to 10. Moreover, SATS in the research is also used to find out if the Statistical Reasoning Learning Environment (SRLE) class has the effect on the statistical reasoning which is supported by the items from 11 to 20. The items were constructed based on the table of "Major changes between a traditional statistics class and an SRLE class" as reported by Garfield and Ben- Zvi (2008). These items were checked by experts in statistics education and the content was validated.

Data Collection Activities and Sampling Techniques

In order to answer the research question 1 and 2, the researcher used descriptive analysis. The data were collected from the questionnaire prepared as attached in the Appendix 1. The questionnaire has 20 items altogether. The data were processed using SPSS software.

Items 1 to 10 were used for analysis in response to research question 1. The total mean and standard deviation for all the items were analysed. Moreover, the mean and standard deviation were analysed item by item where the researcher compared the items to find out the highest mean and standard deviation. Thus, the researcher could find out which items have the most impact on statistical reasoning using *TinkerPlots*.

For answering the research question 2, items 11 to 20 were used for analysis. The total mean and standard deviation for all the items were analysed. Moreover, the mean and standard deviation were analysed item by item where the researcher compared the items to find out the highest mean and standard deviation. Thus, the researcher could find out which items had the most impact on statistical reasoning in learning during SRLE class.

The participants of the study are 23 Year Five pupils from an international school in Selangor. They were conveniently selected from an intact classroom. The pupils were exposed to the intervention activities for 5 weeks using *TinkerPlots and in the SRLE class*. The intervention consists of 8 activities constructed based on the SRLE and constructivist theory.

Results

Table 1 provides some descriptive statistics of analysis of a questionnaire (from Item 1 to 10), including the mean and standard deviation for the experimental group.

Table 1 shows that the number of participants (N) is 23. The table shows how many data points were entered for each condition to determine the students' level of satisfaction or attitude toward learning statistics using TinkerPlots software. The condition means are very important. They show the magnitude of the difference between the groups and it can be seen which group has a higher mean. In this particular table it reflects the level of satisfaction from each item. The item was coded with 1 representing 'Strongly Agree' and 5 is 'Strongly Disagree'. Item 1 shows the mean (M = 1.61, SD = .72) mirrors students mostly agreed to the statement; the mean of item 2 (M = 1.70, SD = .63) also reflects that students mostly agreed; the mean of item 3 (M = 2.30, SD = .63) tells the students agreed too; the next mean of the item which is item 5 (M = 1.96, SD = .56) also shows students mostly agreed, the mean of item 6 (M = 2.65, SD = 1.03) implies the students agreed too and it is followed by item 7 and 8 where the students agreed to the statement as well (M = 2.00, SD = .80 and M = 2.04, SD = 1.36 respectively). However, the mean of item 4 (M = 3.73, SD = 1.17) and item 9 (M = 3.65, SD = 1.15) indicate the students disagreed to the statements. The mean of item 10 (M = 3.61, SD = 1.23) shows students were neutral towards the statement on Tinkerplots.

Table 1 Descriptive Statistics for Item 1 to Item 10 for the Experimental Group

	Mean	Std. Deviation
Item1	1.61	0.72
Item2	1.70	0.63
Item3	2.30	0.63
Item4	3.74	1.18
Item5	1.96	0.56
Item6	2.65	1.03
Item7	2.00	0.80
Item8	2.04	1.36
Item9	3.65	1.15
Item10	3.61	1.23

Table 2 shows the results of a questionnaire using frequency and percentage as indicators of descriptive statistics. Item 1 shows most students (N = 20, 87%) agreed (representing total value of 'Strongly Agree and Agree', the same applies to reporting of other similar items) to the statement saying 'it is easy to learn data handling using TinkerPlots'.

Table 2 The Results of a Questionnaire using Frequency and Percentage as Indicators of Descriptive Statistics

Item1: I have usually been at ease when learning data handling using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Strongly Agree	12	52.2	52.2
Agree	8	34.8	87.0
Undefined	3	13.0	100.0
Total	23	100.0	

The next item, item 2 which is 'easier to understand data by exploring it using TinkerPlots' also was agreed by most of the students (*N* = 21, 91.3%).

Item2: Exploring data has been easy for me to understand using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Strongly Agree	9	39.1	39.1
Agree	12	52.2	91.3
Undefined	2	8.7	100.0
Total	23	100.0	

Item 3 was agreed by most of students (*N* = 14, 60.9%) where students said they 'can test their prediction using TinkerPlots'.

Item3: I can test my prediction using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Strongly Agree	2	8.7	8.7
Agree	12	52.2	60.9
Undefined	9	39.1	100.0
Total	23	100.0	

On the other hand, item 4 'data handling makes me feel uneasy and confused using TinkerPlots' and item 9 received disagreement (representing total value of 'Strongly Disagree and Disagree', the same applies to reporting of other similar items) from the students (*N* = 17, 73.9%, and *N* = 11, 47.8% respectively).

Item4: Data handling makes me feel uneasy and confused using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Strongly Agree	1	4.3	4.3
Agree	4	17.4	21.7
Undefined	1	4.3	26.1
Disagree	11	47.8	73.9
Strongly Disagree	6	26.1	100.0
Total	23	100.0	

For item 9, 'I prefer learning data handling without using TinkerPlots', a few (*N* = 8, 34.8%) were undefined for the items.

Item9: I prefer learning data handling without using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Agree	4	17.4	17.4
Undefined	8	34.8	52.2
Disagree	3	13.0	65.2
Strongly Disagree	8	34.8	100.0
Total	23	100.0	

The next item 5, they 'can analyse and interpret data easily using TinkerPlots' was agreed by the majority of them (*N* = 20, 87%).

Item5: I can analyse and interpret data easily using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Strongly Agree	4	17.4	17.4
Agree	16	69.6	87.0
Undefined	3	13.0	100.0
Total	23	100.0	

Moreover, the following item 6 in which they 'can make inferences easily after using TinkerPlots' was agreed by a minority of them and undefined of the statement (N=20, 87.0%)

Item6: I can make inferences easily after using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Strongly Agree	3	13.0	13.0
Agree	7	30.4	43.5
Undefined	9	39.1	82.6
Disagree	3	13.0	95.7
Strongly Disagree	1	4.3	100.0
Total	23	100.0	

The number and percentage of students agreed to item 7 (*N* = 18, 78.3%) 'can explain what a data says in a survey after using TinkerPlots'.

Item7: I can explain what a data says in a survey after using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Strongly Agree	6	26.1	26.1
Agree	12	52.2	78.3
Undefined	4	17.4	95.7
Disagree	1	4.3	100.0
Total	23	100.0	

The number and percentage (*N* = 16, 69.6%) of students agreed to the statement in item 8, 'data handling is enjoyable and stimulating to me using TinkerPlots'.

Item8: Data handling is enjoyable and stimulating to me using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Strongly Agree	12	52.2	52.2
Agree	4	17.4	69.6
Undefined	3	13.0	82.6
Disagree	2	8.7	91.3
Strongly Disagree	2	8.7	100.0
Total	23	100.0	

In addition, only a small percentage (*N* = 10, 43.5%) (N=4, 17.4%) agreed to item 10, 'data handling is dull and boring because it leaves no room for personal opinion using TinkerPlots'.

Item10: Data handling is dull and boring because it leaves no room for personal opinion using TinkerPlots.

	Frequency	Percent	Cumulative Percent
Strongly Agree	2	8.7	8.7
Agree	2	8.7	17.4
Undefined	5	21.7	39.1
Disagree	8	34.8	73.9
Strongly Disagree	6	26.1	100.0
Total	23	100.0	

The last research question, "What is the experimental group students' attitude to learning statistics in the Statistical Reasoning Learning Environment (SRLE) class after intervention?" was answered using descriptive statistics as well. The results are tabulated in the above Table 2 Item No. 7 and 8.

Table 3 gives some descriptive statistics of analysis of a questionnaire (from Item 11 to 20), including the mean and standard deviation for the experimental group. The number of participants in each condition (N) is 23. The table shows how many data points were entered for each condition to determine the students' level of satisfaction or attitude to learning statistics using the Statistical Reasoning Learning Environment (SRLE) class. Due to the item was negatively coded, 1 represents 'Strongly Agree' and 5 represents 'Strongly Disagree'. The condition means are very important. They show the magnitude of the difference between the groups and it can be seen which group has a higher mean. The table mirrors the level of satisfaction for each item. Item 11 shows the mean (M = 2.04, SD = 1.11) mirrors students mostly agreed to the statement; the mean of item 12 (M =3.73, SD = 1.10) also reflects the students mostly agreed; the mean of item 13 (M = 2.52, SD = 1.16) tells the students agreed too; the next mean of the item which is item 14 (M = 2.17, SD = .78) also shows students mostly agreed; the mean of item 15 (M = 1.04, SD = .21) implies the students agreed too and it is followed by item 17 and 18 where the students agreed to the statement as well (the means are M = 1.30, SD = .56 and M = 1.87, SD = 1.21 respectively). However, the mean of item 16 (M = 4.52, SD = 1.04), item 19 (M = 4.74, SD = .54) and item 20 (M = 4.65, SD = .57) indicate the students disagree to the statements.

Table 3 Descriptive Statistics for Item 11 to Item 20 for the Experimental Group

	Mean	Std. Deviation
Item11	2.04	1.11
Item12	3.74	1.10
Item13	2.52	1.16
Item14	2.17	0.78
Item15	1.04	0.21
Item16	4.52	1.04
Item17	1.30	0.56
Item18	1.87	1.21
Item19	4.74	0.54
Item20	4.65	0.57

Table 4 shows the results of a questionnaire using frequency and percentage as indicators of descriptive statistics by stating the frequency and percentage. Item 11 is agreed (representing total value of 'Strongly Agree and Agree', the same applies to reporting of other similar items) by students (*N* = 16, 69.5%), 'the teacher facilitates me to develop knowledge through discussion and activities'.

Table 4 The Results of a Questionnaire using Frequency and Percentage as Indicators of Descriptive Statistics

Item11: The teacher facilitates me to develop knowledge through discussion and activities**.**

	Frequency	Percent	Cumulative Percent
Strongly Agree	9	39.1	39.1
Agree	7	30.4	69.6
Undefined	5	21.7	91.3
Disagree	1	4.3	95.7
Strongly Disagree	1	4.3	100.0
Total	23	100.0	

Next, item 12 (the teacher delivers knowledge by telling and explaining) is also agreed by them (*N* = 15, 65.2%).

Item12: The teacher delivers knowledge by telling and explaining.

	Frequency	Percent	Cumulative Percent
Strongly Agree	1	4.4	4.4
Agree	2	8.7	13.1
Undefined	5	21.7	34.8
Disagree	9	39.1	73.9
Strongly Disagree	6	26.1	100.0
Total	23	100.0	

It followed by item 13 (the teacher poses questions and guides a discussion) is agreed by the experimental group of students (N=15, 65.1%)

Item13: The teacher poses questions and guides a discussion.

	Frequency	Percent	Cumulative Percent
Strongly Agree	4	17.4	17.4
Agree	9	39.1	56.5
Undefined	6	26.1	82.6
Disagree	2	8.7	91.3
Strongly Disagree	2	8.7	100.0
Total	23	100.0	

Item 14 (students answer other students' questions and are asked if they agree or disagree with answers) and item 15 (peer and teacher feedback), both the items were agreed too with responses for item 14 (*N* = 18, 78.2%) and item 15 (*N* = 23, 100%) respectively.

Item14: Students answer other students' questions and are asked if they agree or disagree with answers.

	Frequency	Percent	Cumulative Percent
Strongly Agree	3	13.0	13.0
Agree	15	65.2	78.3
Undefined	3	13.0	91.3
Disagree	2	8.7	100.0
Total	23	100.0	

Item15: Peer and teacher feedback.

	Frequency	Percent	Cumulative Percent
Strongly Agree	22	95.7	95.7
Agree	1	4.3	100.0
Total	23	100.0	

Almost all (*N* = 22, 95.6%) of students agreed to item 17 (I use real data) and many (*N* = 17, 73.4%) agreed to the statement in item 18 (I generated data from surveys).

***Item17*:** I use real data

	Frequency	Percent	Cumulative Percent
Strongly Agree	17	73.9	73.9
Agree	5	21.7	95.7
Undefined	1	4.3	100.0
Total	23	100.0	

Item18: I generated data from surveys.

	Frequency	Percent	Cumulative Percent
Strongly Agree	13	56.5	56.5
Agree	4	17.4	73.9
Undefined	3	13.0	87.0
Disagree	2	8.7	95.7
Strongly Disagree	1	4.3	100.0
Total	23	100.0	

Although most of the statements were agreed, a few statements were disagreed too. Item 16 (the teacher answers all the questions) were disagreed (representing total value of 'Strongly Disagree and Disagree', the same applies to reporting of other similar items) by students (N = 21, 91.3%) and for item 19 (I use textbooks to learn data handling), most students (N = 22, 95.7%) disagreed while for item 20 (my teachers focused mainly on memorization of facts and procedures), most of them (N = 22, 95.7%) also disagreed.

Item16: The teacher answers all the questions.

	Frequency	Percent	Cumulative Percent
Strongly Agree	1	4.3	4.3
Agree	1	4.3	8.7
Disagree	4	17.4	26.1
Strongly Disagree	17	73.9	100.0
Total	23	100.0	

Item19: I use textbooks to learn data handling

	Frequency	Percent	Cumulative Percent
Undefined	1	4.3	4.3
Disagree	4	17.4	21.7
Strongly Disagree	18	78.3	100.0
Total	23	100.0	

Item20: My teachers focused mainly on memorization of facts and procedures.

	Frequency	Percent	Cumulative Percent
Undefined	1	4.3	4.3
Disagree	6	26.1	30.4
Strongly Disagree	16	69.6	100.0
Total	23	100.0	

Discussion

In a short period of time, pupils had the opportunity to explore and learn statistics using TinkerPlots. The results indicated an overall positive attitude. This is due to the visualization features of TinkerPlots (refer exemplar in Appendix 2) to enhance the pupil's ability to do statistical reasoning with provided data given (Biehler et al., 2017). Pupils had also enjoyed learning statistics in SRLE class environment from the positive results obtained. This can be explained by the visualization and reasoning of statistical concepts that can be implemented in TinkerPlots (Pfannkuchet al., 2018). Furthermore, the understanding of the underlying statistical models and TinkerPlots' features assisted pupil learning in the SRLE environment (Manor & Ben-Zvi, 2017).

This research implemented the Statistical Reasoning Learning Environment (SRLE) in order to make an attempt to open a path for students to explore and encourage them to make statistical reasoning. The students showed positive attitude in learning data handling when they were given the chance to learn in the SRLE class environment. The finding is consistent with what Gal (2002) suggested in previous research. He mentioned understanding, interpreting, and reacting to real-world messages that contain statistical elements go beyond simply learning statistical content. He suggested that these skills are built on an interaction between several knowledge bases and supporting dispositions. Statistical literacy skills must be activated together with statistical, mathematical, and general world knowledge. The students in the research make statistical reasoning easily after exposure to real life situations. Lastly, the students showed positive attitude in learning data handling using TinkerPlots software. Konold and Miller (2005) concluded that TinkerPlots allows students systematically to build their understanding of statistical representations and concepts through exploring data.

Conclusion

This study has made important contributions in instilling positive attitudes among year five primary students toward learning statistical reasoning using *TinkerPlots* in the Statistical Reasoning Learning Environment (SRLE) class.

Summary and Significance

The analysis from this study has proven that the students were motivated to do better in statistical reasoning by implementing the lesson in SRLE class using TinkerPlots software. The students enjoyed the learning environment of statistics by handling real data. They also take initiative to learn on their own which is student centred by exploring the data collected. Thus, this study concludes that by implementing appropriate technology tools in mathematics lesson with suitable learning environment for students, we can affect their attitude toward learning.

Limitations, Implications and Future Directions

However, the findings presented in this paper should be interpreted in the light of the study's limitations. First, one-group posttest only research design is the simplest and weakest quasi-experimental design in terms of level of evidence as the measured outcome. The results are based on the students' attitudes from a Year 5 class in an international school in Selangor. Second, the results of this study cannot be generalized to the population since they pupils were from an intact classroom. On a final note, this study provides an insight of pupil's attitude in learning statistical reasoning using the SRLE class. The positive attitude of pupils seems beneficial in designing activities using TinkerPlots to assist pupils' learning in the Statistical reasoning learning environment (SRLE).

The findings of the research are supported by Olani et al. (2010). The impact of classroom contexts on developing students' statistical reasoning and thinking abilities as well as on improving their attitude and beliefs requires further study. Even if further empirical study is first required on this issue, it is worth pointing out the appropriateness of using personalised and specific items when measuring components of affect behaviour.

Significance and Contribution in Line with LSM Philosophy

The article contributes to the knowledge on the attitudes of Year 5 students in learning statistical reasoning using Tinkerplots in the classroom environment with exemplars illustrated. Students responded positively to the items in the survey.

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Appendix 1: Survey on 'Students Attitudes towards Statistics' (SATS)

Please circle one of the levels of satisfaction after reading the content.

SA = Strongly Agree	A = Agree	U = Undefined
	D = Disagree	SD = Strongly Disagree

Item	Content	Level of Satisfaction				
1	I have usually been at ease when learning data handling using *TinkerPlots*.	SA	A	U	D	SD
2	Exploring data has been easy for me to understand using *TinkerPlots*.	SA	A	U	D	SD
3	I can test my prediction using *TinkerPlots.*	SA	A	U	D	SD
4	Data handling makes me feel uneasy and confused using *TinkerPlots*.	SA	A	U	D	SD
5	I can analyse and interpret data easily using *TinkerPlots*.	SA	A	U	D	SD
6	I can make inferences easily after using *TinkerPlots.*	SA	A	U	D	SD
7	I can explain what a data says in a survey after using *TinkerPlots.*	SA	A	U	D	SD
8	Data handling is enjoyable and stimulating to me using *TinkerPlots.*	SA	A	U	D	SD
9	I prefer learning data handling without using *TinkerPlots.*	SA	A	U	D	SD
10	Data handling is dull and boring because it leaves no room for personal opinion using *TinkerPlots*.	SA	A	U	D	SD
11	The teacher facilitates me to develop knowledge through discussion and activities.	SA	A	U	D	SD
12	The teacher delivers knowledge by telling and explaining.	SA	A	U	D	SD
13	The teacher poses questions and guides a discussion.	SA	A	U	D	SD
14	Students answer other students' questions and are asked if they agree or disagree with answers.	SA	A	U	D	SD
15	Peer and teacher feedback.	SA	A	U	D	SD
16	The teacher answers all the questions.	SA	A	U	D	SD
17	I use real data.	SA	A	U	D	SD
18	I generated data from surveys.	SA	A	U	D	SD
19	I use textbooks to learn data handling.	SA	A	U	D	SD
20	My teachers focused mainly on memorization facts and procedures.	SA	A	U	D	SD

Appendix 2: Visualisation in Tinkerplots