The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM)
ISSN: 2602-3199

The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM), 2024

Volume 27, Pages 155-163

IConTech 2024: International Conference on Technology

Use of Android-Based E-Modules for Statistical Thinking Abilities

Sardin Sardin
The Education University

Martadiputra Bap
The Education University

Andika Pratama
Universitas Pendidikan Indonesia

Absract: Developing statistical thinking skills is an important need in the industrial era 4.0 and society 5.0. Where the availability and openness of data is not limited by space and time. Statistical thinking is very important to help students focus so they can consume educated and accurate information. Statistical thinking is a way of understanding the complex world by describing it in relatively simple terms. This research aims to improve students' Statistical Thinking abilities by using Android application-based learning media. The method used in this research uses the literature study method. Data collection was carried out through literature reviews from several relevant studies, then continued with content analysis. The results of this research show that in general the use of Android-based E-Modules can improve statistical thinking abilities. The use of Android-based E-modules also increases students' learning activities to become more active during the learning process. Apart from that, another positive impact is the acceleration and improvement of students' mathematics skills. The mobile characteristics of Android applications provide opportunities for students to re-study material they have not mastered anywhere and at any time.

Keywords: E-module, Android application, Statistical thinking

Introduction

The concept of the Society 5.0 era was first conveyed by Japanese Prime Minister Shinzo Abe by encouraging the role of humans in overcoming progress in the Industrial Revolution 4.0. In this 5.0 era, humans are required to have more problem-solving abilities, critical thinking abilities, and creative abilities (Nurjanah et al., 2021). The priority of this era is the ability of society to adapt to the future by having HOTS capabilities(Higher-order thinking Skills) to think complexly, hierarchically, and systematically in everyday life. The availability of high-level technology has become a trend for automation and data exchange during the Industrial Revolution 4.0 as it is the Internet of Things (IoT) and artificial intelligence (Ellitan, 2020). Along with this progress, it has an impact on life throughout the world which is full of turmoil and full of uncertainty. With the presence of the era of society 5.0, it can be a solution to existing problems (Sugiono, 2020).

The fundamental principle in the era of Society 5.0 is the role of humans together with the technology that has been created. Humans create a balance between economic progress and solving social problems through an interconnected system between the virtual world and the real world(Ellitan, 2020). The relationship between the Industrial Revolution 4.0 and the era of society 5.0 is the use of big data. Big data that follows the development of the Society 5.0 era is found in various fields, such as the use of technology wearable (Sugiono, 2020). Wearable technology is a device Internet of Things (IoT) found on smartphones physically worn by individuals to track, analyze, and send personal data. This device is commonly used to assist communication

and navigation activities in everyday life. But then, it was transformed into a technology for collecting big data information contained within smartphones.

Furthermore, the era of Society 5.0 is also related to data analysis using high-performance computers to solve the issue of environmental change, a smart city that is safe, comfortable, and efficient. So this needs to be adapted to the world of education in Indonesia. Education currently faces many challenges in meeting 21st-century learning targets. The current challenge is a call to integrate Information and Communication Technology (ICT) into learning activities. 21st-century learning habits can be seen in the increasing use of technology. There is a structured movement to apply a combination of humans and technology in life so that the world of work requires people who can take the initiative, think critically, and be creative and capable of solving problems (Batubara, 2018). Teachers as important agents in the learning process are the main potential for scientific development. Teachers must always explore their potential to improve the quality of learning. There are many ways to improve the quality of learning, including using learning design (Komariah et al., 2018) that involves technology.

In the era of digitalization, the government requires Information and Communication Technology (ICT) subjects in every school, then it is recommended to integrate technology into every learning process, including mathematics learning. The application of digital technology in learning can help make learning more effective and interesting, presenting events that rarely occur, and showing events that can make it easier for students to understand abstract material (Anita & Nugraha, 2022). The presence of technology can help students improve their problem-solving abilities.

Branca states that problem-solving skills are the core of mathematics learning (Creswell, J.W. 2014). Applying statistical problem-solving or decision-making skills requires statistical thinking. Thought terms statistics were first created by Wilks in a presidential speech at the forum American Statistical Association (Wilks, 1951), when he quotedWells that “Statistical thinking will one day be as necessary to every citizen as the ability to read and write!” (Coleman, 2013). Statistical thinking skills are not only needed when students are studying but are needed when someone makes decisions (Meylasari, 2020). NCTM (2020) includes the content of data analysis and probability into one of five standards which include number operations, algebra, geometry, measurement, and data analysis and probability.

Several higher-order thinking skills such as asking questions, making interpretations and estimates, reasoning, critical thinking, drawing interference, metacognition, the ability to detect inadequate reasoning, problem reasoning skills, and making mental calculations and estimates are also included in statistical thinking abilities. Statistical knowledge helps in the decision-making process and in solving real-world problems involving data. However, the reality in the field is that students have difficulty learning statistics. According to previous research, the source of secondary school students' difficulties is teaching unrelated statistical concepts and procedures, learning without real examples, and also prioritizing memorization over conceptual understanding (Çakmak & Durmus, 2015; Ben-Zvi & Garfield, 2008). According to Ben-Zvi and Garfield (2008), conceptual learning is necessary for the development of statistical thinking because conceptual learning involves understanding and interpreting data as well as making conclusions from the data found.

Statistical thinking is not just about carrying out statistical calculations or defining concepts, but this requires interpretation, reasoning, deduction, and making generalizations about data (Mooney, 2002; Ben-Zvi & Garfield, 2008). Therefore, statistical thinking requires more than just knowing concepts and procedures and doing calculations. Considering that statistical data plays a large part in modern daily life, it is important to develop statistical thinking while studying mathematics at school. Statistical thinking is the ability to describe, organize, present, analyze, and interpret data as well as apply an understanding of statistical concepts in everyday life by providing critical evaluations and making generalizations (Gal, 2002). If statistical thinking skills are high then understanding of the definition of statistical objects and attention to statistics are also good (Aizikovitsh-Udi et al., 2016).

Statistical thinking can develop students' critical thinking, especially on how to receive information, manage the truth of information, and provide comments (Aizikovitsh -Udi, 2016, 2017; Lizarelli et al., 2020). Moreover, it relates to students' creativity in solving problems with various solutions (Akaike, 2010). This is also able to develop students' reasoning in decision-making and helps build a basic understanding of statistical material (Garfield et al., 2015). In this case, understanding students' statistical thinking in general and examining students' stages of statistical thinking, in particular, is very important to inform learning practices, especially problem-solving activities in the classroom, which can continue to be improved to support the development of students' thinking (Marlissa & Widjajanti, 2015; Sopamena et al., 2018). Observing students' statistical thinking

processes can be done by giving students problems so that the cognitive processes that occur can be observed directly (Lailiyah et al., 2020).

Statistical thinking is everything a statistician does, including summarizing data, solving statistical problems, drawing conclusions through procedures, and explaining interpretations of results (Chance, 2002). Hogg et al, 2000) defines statistical thinking as the ability to formulate appropriate questions about data, how to collect effective data to answer them, and how to summarize and interpret information, and come to conclusions. Mooney and Edwar (2002) define statistical thinking as describing data, organizing it, summarizing it, representing or displaying it, analyzing it, and interpreting it.

According to Chan and Ismail (2014), statistical thinking is the ability to understand the statistical process as a whole and apply statistical understanding to real problems by providing criticism, evaluation, and making generalizations in terms of describing data, organizing data, representing data, analyzing and interpreting data. This is in line with the opinion of Ulusoy and Altay (2017) who state that there are four processes/constructs in statistical thinking based on the framework of Jones et al. (2000) namely describing data, organizing data, representing data, analyzing and interpreting data. The first process, describing data, shows that someone can completely read the data presented in the data display. The second process, data organization, and reduction, reveals that one can group data into classes in various ways and can explain the size concentration, and distribution of the data. The third process, data representation, states that someone can present the data with various data displays. The fourth process, analyzing and interpreting data, shows that someone can provide contextual responses and make conclusions or predict population/sample characteristics based on data (Ulusoy & Altay, 2017). In this research, statistical thinking refers to students' cognitive activities that reveal the ability to understand how to describe, organize reduce, represent analyze, and interpret data, which is implemented in real problems.

Statistical Thinking involves critical evaluation and analysis of statistical research results. Gomez-Blancarte et al (2021) also agree that statistical thinking involves a comprehensive understanding of statistical concepts and processes, including the rationale behind various methods of data analysis and the context of statistical research conducted. Abbiati et al (2021)highlight in their research that statistical thinking differs from mathematical thinking in that it focuses on the variability and production of data and relies heavily on one's interpretation and critical judgment. Delmas (2004) defines statistical thinking as a person's ability to know when and how to apply statistical knowledge and procedures effectively and efficiently. This application involves a good understanding of statistical concepts and methods and using them appropriately in different situations. The ability to integrate statistical conclusions with the context of a problem is an important aspect of statistical thinking.

Statistical Thinking involves critical evaluation and analysis of statistical research results. Gomez-Blancarte et al (2021) also agree that statistical thinking involves a comprehensive understanding of statistical concepts and processes, including the reasons behind various data analysis methods and the context of statistical research conducted. Abbiati et al. (2021) highlight in their research that statistical thinking differs from mathematical thinking because it focuses on the variability and production of data and relies heavily on one's interpretation and critical judgment. Delmas (2004) defines statistical thinking as a person's ability to know when and how to apply statistical knowledge and procedures effectively and efficiently. This application involves a good understanding of statistical concepts and methods and using them appropriately in different situations. The ability to integrate statistical conclusions with the context of a problem is an important aspect of statistical thinking.

Applying statistical thinking skills to a problem in mathematics learning activities is very important. Based on the results of Kim's research (2020), students can understand mathematics learning optimally by using teaching aids or learning media that are appropriate to their level of development. The use of media in the learning process aims to make the learning process effective and efficient so that the quality of education can be improved (Batubara, 2018). The use of learning media must adapt to student characteristics, where students currently live side by side with technology. Android applications are one of the learning media choices that every student is interested in nowadays because they are easy to use and can be taken anywhere. The use of Android applications is intended to complement existing learning and provide opportunities for students to re-study material they have not mastered anywhere and anytime (Nurwita et al., 2023). Using this Android application can certainly provide students with a different experience in the mathematics learning process.

The choice of learning media needs to be adjusted to student characteristics because media can have a different learning motivation influence on each student. Azkia et al. (2023). The closer the student's characteristics are to

the media used, the higher the motivational influence generated by the media. Along with changes in progress, technology has been created that makes human activities easier, one of which is the smartphone. Smartphones, which were originally used as communication tools, now have more than their basic function. Various features have been embedded, such as image and video processing, document processing, and others. The growth of mobile devices, especially smartphones, has experienced very rapid growth from year to year. According to www.sampoernauniversity.ac.id, there will be 167 million smartphone users in Indonesia in 2022. This number is believed to continue to grow rapidly, especially in urban areas. Seeing the number of smartphone users, Android-based learning (blended learning) will be very supportive (Fitriani et al., 2021).

Research conducted by Fitriani et al. (2023), obtained the results that students who were taught using the blended learning learning model had a better rotation of cognitive conflict strategies than those taught through conventional learning. Research by Indrapangastuti et al. (2021) also states that blended learning can significantly improve learning achievement. Research by Fitriani et al. (2021) obtained results that e-book-based blended learning integrated with YouTube in mathematics learning geometry material met the criteria of valid, practical, and effective. Furthermore, the results of research by Setiawan et al. (2021), found that the average student in Indonesia who uses blended learning effectively can improve their mathematical abilities. Therefore, teachers are expected to be able to implement blended learning effectively. Educators are required to be able to keep up with technological developments to improve the quality of education by continuing to innovate and be creative. Teachers can develop technology-based, student-oriented learning systems and facilitate their needs with learning activities that are challenging, active, creative, innovative, effective, and fun (Nurjanah et al., 2021). This policy is used in the hope that it can have a better impact on the sustainability of education. The use of technology in the 21st century is highly recommended in education so that teachers and students can adapt and utilize technology in facing the industrial era 4.0 and society era 5.0.

The use of technology in education is very useful for facing future challenges. So blended learning must be used in schools from now on. Baloran's (2020) research states that students and teachers must get used to blended learning from now on to face future challenges. Learn from the COVID-19 experience, when learning methods were suddenly shifted everyone was not ready to do blended learning. Therefore, blended learning will continue forever, not because of COVID-19, but rather because it is a learning process that has positive benefits for Indonesian education in the future. This has the positive impact that blended learning has become an option for learning on campuses (Lapitan et al., 2021). In response to this, of course, there needs to be media that supports learning so that it becomes more effective. Research by Setiawan et al. (2021) states that blended learning, which is used effectively, can improve mathematical abilities. Therefore, the author provides a solution to overcome this problem, namely by developing innovative learning media in the form of electronic modules (e-modules) that can be used in blended learning. Research by Anik et al. (2019) states that e-modules are very significant in improving student learning outcomes.

Based on the explanation above, developing e-modules for blended learning learning is believed to provide better learning outcomes. Moreover, the e-module developed takes into account student characteristics in the learning process. The difference between Android-based e-modules and other learning models lies in the stage of preparing the detailed design section that integrates technology into the e-module. Apart from that, the e-module was developed using an Android-based application, namely sketcware, so that the e-module can be used on laptops as well as cell phones and Android online or offline. Furthermore, in the e-module, there is an independent learning section with learning video facilities that train students to understand the material independently or collaboratively, and each activity contained in the e-module has a problem-solving stage to achieve statistical thinking skills so this becomes a novelty in the study.

Method

The method used in this research is literature/library study. Literature study is an activity to study the theories underlying research, both theories relating to the field of science being researched and methodology. Putrihapsari and Fauziah (2020)defines literature study as research carried out by reviewing various literature studies required in the research. The purpose of using the literature study method in this research is as a first step in planning further research by utilizing literature to obtain data in the field without needing to go directly. The data sources used as references in this research are relevant library sources as primary data sources. research data, research reports, scientific journals, books, theses, theses, dissertations, and even newspapers that are relevant to the topic being discussed. After obtaining the data source as a reference, it is continued with analysis of the literature review data which is carried out using content analysis. Content analysis is where the researcher examines a text objectively to get an overview of the content as it is, without the intervention of the

researcher(Ahmad J, 2018).In this case, the researcher conducts an in-depth discussion of the content of information from a data source which requires setting time to read and examine the data so that he can find a solution according to the topic being discussed. It is hoped that these results can answer the problem and be used as a consideration in the scope of using Android-based e-modules to achieve the capabilities of statistical *thinking* learners.

Results and Discussion

Mastering basic mathematical concepts is the basic foundation that students who study mathematics must have in the future (Suhandri et al., 2017). This is intended so that students do not experience learning obstacles when studying mathematics at a higher level such as studying statistics. However, existing facts show that many students experience difficulties when they have to solve the problems they study (Hermaini & Nurdin, 2020). This difficulty occurs because students do not understand the basic concepts that have been studied previously so when faced with problems, students tend to be confused, and even forget which concept to use to find a solution to the problem being faced. According to Ben-Zvi and Garfield (2008), several students' challenges in understanding mathematical concepts, especially statistics, which can interfere with their statistical thinking abilities include many statistical ideas and rules that are complicated, difficult, and/or counterintuitive. Teachers find it difficult to motivate students to engage in calculating work in statistics learning. Many students have difficulty with basic mathematics such as fractions, decimals, and algebraic formulas which interferes with learning statistical content.

Based on the results of a survey conducted by Makmuri et al. (2021), it was found that learning using books makes learning less interesting, mathematics lessons are still considered unpleasant and difficult lessons. Limited media and learning resources are also considered to be one of the factors that cause students to have difficulty learning. Azkia et al. (2023) stated that most students find it difficult to construct and visualize mathematical problems (geometry and statistics). This material requires imaginative thinking to explore relationships between points, lines, planes, and between data. Based on the problems and difficulties experienced by students, learning media is needed.

Using learning media can make it easier for students and teachers to carry out learning activities. Learning media has an important role in the student learning process because abstract learning materials can be made concrete in learning using the animations presented (Kuswanto & Radiansah, 2018; Novianti, 2018; Shodikin, 2017). A good solution that can answer this problem is to use digital-based learning media. Azkia et al. (2023) stated that digital-based learning media has a big influence on mathematics learning outcomes. Apart from that, in line with research by Tumangkeng et al. (2018) where electronic learning media makes a greater contribution than print media such as books. This is also in line with the results of research conducted by Tamur et al. (2020) that the effectiveness of using mathematics applications provides an average effect size in the high category and based on the results of research conducted by Wungguli and Yahya (2020) that digital-based learning media makes it easier for students to understand abstract mathematical concepts. With the development of this learning media application, it is hoped that it can create a learning atmosphere that is more practical, and fun and can be accessed anywhere and at any time. This learning media application is presented in an attractive package, so it is hoped that it can increase students' interest in studying mathematics. The learning media developed is an Android-based application. So this learning media can be easily operated because students are used to using smartphones in everyday life. This learning media is included in the e-module-based media category which uses blended learning.

According to Tenmau et al. (2023) stated that Android-based learning media has advantages, namely: applications can be run on all versions of Android, applications can be run on all screen resolutions, and applications can be used anytime and anywhere. The existence of Android-based learning media can be an alternative learning resource for students so it is hoped that students can be motivated to be enthusiastic about learning. This learning media can motivate teachers to always explore their creativity in using appropriate learning media so that it attracts students' interest and they want to learn in a class atmosphere that is fun, effective, conducive, and active. Apart from that, research conducted by Muyaroah and Fajartia (2017), the results obtained by Android-based learning media have advantages, namely: (1) the media has an attractive design appearance for students, (2) it is easy to operate, and understood and understandable by students, (3) students do not feel bored when using it, (4) can be used independently either at school or at home. Based on relevant literature studies, the use of Android e-modules can improve students' thinking skills when compared to other learning media, this is because Android modules have several advantages including a) broad application and design prospects so that the delivery of material becomes more interesting and can increase student learning

motivation, b) able to present movements to shape the learning experience of students, c) is flexible so that it can be used anytime and anywhere (blended learning), and d) is more practical because it can contain materials, assignments, learning videos and also direct learning activities (touch screen).

According to Hamzah et al. (2022) said that the use of Android-based e-modules is effective in improving students' mathematics learning outcomes. According to Kartiko & Mampouw (2021), the Android application-based E-module supported by LKPD is very effective in helping students achieve 85% complete learning of mathematics material. according to Astuti et al. (2022) stated that the Android-based Statistics E-Module had a statistically significant effect on students' mathematics learning outcomes. According to Dewimarni and Rizalina (2022), Android-based statistics learning media (e-modules) are effective in improving statistics learning outcomes. According to Rismayanti et al. (2022), a modular-assisted e-module on smartphone Android is interesting and worth using and can improve the critical thinking skills of mathematical students. According to Nurwita F, et al (2023), that android application-based learning media (e-modules) can improve the mathematical problem-solving skills of learners. Learning outcomes also show a positive impact on accelerating and improving students' mathematical abilities because the characteristics of Android application-based e-modules provide students with the opportunity to re-study material they have not mastered anywhere and anytime. This also cannot be separated from how to teach statistical material to support the abilities of statistical thinking learners.

Based on research results (Hamzah et al., 2022; Kartiko & Mampouw, 2021; Astuti et al, 2022; Dewimarni &; Rizalina, 2022; Rismayanti et al., 2022; Nurwita et al., 2023) the presentation of the material strongly supports statistical thinking skills. The characteristics of the material presented from the results of these studies construct the characteristics of statistical thinking skills according to Martadipura, (2012), namely, there are four constructions, namely: (1) describe the display of data, (2) organize and reduce data, (3) representing data, (4) analyzing and interpreting data. The characteristics of the results of the researchers above also apply the stages of cognitive thinking to the SOLO model (Structure of the Observed Learning Outcome) from Biggs and Collis (1991) and Jones, et al. (2000) divide the level of statistical thinking into four, namely: 1) Idiosyncratic; 2) Transitional; 3) Quantitative; and 4) Analytical.

Statistical thinking is known as a cognitive action in which students engage in statistical tasks, such as describing, organizing, summarizing, representing, and analyzing data (Mooney et al. 2001). This means statistical thinking is a mental process that allows students to use statistical methods to describe, analyze, evaluate, and make decisions, while the ability to think here means mental thinking, which arises from activities carried out by students. The statistical thinking process is very important to answer future challenges so it needs to be emerged to form flexible and organized mental processes carried out by students. The aim of applying statistical thinking skills is to solve statistical problems and problems through the use of several skills of induction, deduction, interpretation, and perception of relationships which refer to the ability to handle data descriptively. Further than that is how to make decisions to apply them in everyday life.

Conclusion

The use of Android-based e-modules in mathematics learning is very urgent and crucial for teachers in the industrial era 4.0 and society era 5.0. Previous research shows the advantages and capabilities of Android-based e-modules that can improve students' mathematics learning outcomes, including statistical thinking abilities. The need for students in guidance activities and dependence on learning assistance to understand concepts is still very high. With Android-based e-modules, it is hoped that you can learn independently anytime and anywhere. Thus, students' ability to define problems and direct them to find the answer/resolution of the problem given can be realized. Android application-based e-modules can be a learning alternative that can be applied during the distance learning period. Teachers can assist students through electronic teaching materials distributed to students, learning media, or step-by-step guidance through Questions and discussions can be done online or offline. Teachers need to design learning media well so as not to cause students to depend on the assistance provided. The application of Android-based e-module learning to achieve statistical thinking skills in mathematics learning using blended learning needs to be followed up.

Recommendation

The development of Android-based e-modules is very relevant to the Industrial Revolution 4.0 era, especially during face-to-face and virtual learning. Therefore, the author recommends using Android-based e-module

learning media so that statistical material can be developed. The use of LKPD to support blended learning needs to be organized and planned well so that it can function as a tool for controlling students' learning progress as well as an evaluation tool for indicators of students' achievement of statistical thinking abilities.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM Journal belongs to the authors.

Acknowledgments or Notes

* This article was presented as an oral presentation at the International Conference on Technology (www.icontechno.net) held in Alanya/Turkey on May 02-05, 2024.

* In the funding stage for doctoral studies and funding for journal articles and international seminars, the author received funding support from the Indonesian Education Scholarship by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia. Therefore, I would like to thank the Minister of Education, the Education Fund Management Institute (LPDP), and the head of the Education Financing Service Center (PUSLAPDIK) of the Republic of Indonesia.

References

Abbiati, N. N., Fabrizio, M. D. C., Lopez, M. V., Perez, A., Plencovich, M. C., & Cueto, G. (2021). Attitudes related to students' performance in statistics in university programs in Argentina. *Statistics Education Research Journal*, *20*(2), 8-8.

Ahmad, J. (2018). *Desain penelitian analisis ısi (content analysis)* (pp.1-20). Retrieved from https://d1wqtxts1xzle7.cloudfront.net/.pdf

Aizikovitsh-Udi, E., Kuntze, S., & Clarke, D. (2016). Connection between statistical thinking and critical thinking: A case study. In D. Ben-Zv., & K. Makar (Eds.), *The teaching and learning of statistics*. Cham: Springer.

Akaike, H. (2010). Making statistical thinking more productive. *Annals of the Institute of Statistical Mathematics*, *62*(1), 3–9.

Anik, K., Sudana, I. N., & Setyosari, P. (2019). The effects of electronic modules in constructivist blended learning approaches to ımprove learning ındependence. *International Journal of Innovation, Creativity and Change*, *9*(10), 82–93.

Anita, T., & Nugraha, F. W. (2022). Sosialisasi pembelajaran berbasis digital pada masyarakat. *Darma Cendekia*, *1*(1), 23-29.

Azkia, N. F., Muin, A., & Dimyati, A. (2023). Pengaruh media pembelajaran digital terhadap hasil belajar matematika: meta analisis. *Jurnal Pembelajaran Matematika Inovatif*, *6*(5), 18731886.

Baloran, E. T. (2020). Knowledge, attitudes, anxiety, and coping strategies of students during Covid-19 pandemic. *Journal of Loss and Trauma*, *25*(8), 635–642.

Batubara, H. H. (2018). Pengembangan media pembelajaran matematika berbasis android untuk siswa SD/MI. *Muallimuna: Jurnal Madrasah Ibtidaiyah*, *3*(1). 26-27.

Ben-Zvi, D., & Garfield, J. B. (Eds.). (2004). *The challenge of developing statistical literacy, reasoning and thinking* (pp. 3-16). Dordrecht: Kluwer Academic Publishers.

Cakmak, Z. T. & Durmus, S. (2015). Determining the concepts and subjects in the area of learning statistics and probability that 6-8th grade math students have difficulties. *Abant Izzet Baysal Universitesi Egitim Fakultesi Dergisi*, *15*(2), 27–58.

Chance, B. L. (2002). Components of statistical thinking and implications for instruction and assessment. *Journal of Statistics Education*, *10*(3), 1-17.

Chan, S.W., & Ismail, Z. (2014). Developing statistical reasoning assessment ınstrument for high school students in descriptive statistics. *Procedia-Social and Behavioral Sciences*, *11(*6), 4338-4343.

Coleman S. Y. (2013). Statistical thinking in the quality movement 725 years. The *TQM Journal*, *25* (6), 597-605.

Creswell J. W. (2014). *Desain penelitian pendekatan kualitatif, kuantitatif, dan campuran.* Amerika Serikat: SAGE.

Delmas, R. C. (2004). A comparison of mathematical and statistical reasoning. In *The challenge of developing statistical literacy, reasoning and thinking* (pp. 79-95). Dordrecht: Springer Netherlands.

Dewimarni, S., & Rizalina, R. (2022). Efektivitas media pembelajaran statistika berbasis Android untuk meningkatkan hasil belajar statistika. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *6*(2), 1946-1952.

Ellitan, L., (2020). Competing in the era of ındustrial revolution 4.0 and society 5.0. *Jurnal Maksipreneur Manajemen Koperasi Dan Entrepreneurship*, *10*(1),1-12.

Fitriani. (2023). *Pengembangan e-modul untuk blended learning dalam pencapaian kemampuan pemecahan masalah dan resiliensi matematis siswa kelas*. VII. Repository UPI: Disertasi. Universitas Pendidikan Indoensia, Bandung.

Fitriani., Fatimah, S., & Herman, T. (2021). Blended learning based on ebook integrated Youtube in learning mathematics. *Journal of Physics Conference Series*, *1806*(1), 1–7.

Gal, I. (2002). Adult's statistical literacy: meanings, components, responsibilities.. *International Statistical Review*, *70*(1), 1–25.

Garfield, J., Le, L., Zieffler, A., & Ben-Zvi, D. (2015). Developing students' reasoning about samples and sampling variability as a path to expert statistical thinking. *Educational Studies in Mathematics*, *88*(3), 327–342.

Gomez-Blancarte, A. L., Chavez, R. R., & Aguilar, R. D. C. (2021). A survey of the teaching of statistical literacy, reasoning, and thinking: Teacher's classroom practice in Mexican high school education. *Statistics Education Research Journal*, *20*(2), 13-13.

Hamzah, U., Syam R., Marwan., Juhari A., (2022). Pengembangan E-modul matematika berbasis aplikasi Android. *Seminar Nasional Hasil Penelitian.* LP2M-Universitas Negeri Makassar.

Hermaini, J., & Nurdin, E. (2020). Bagaimana kemampuan pemecahan masalah matematis siswa dari perspektif minat belajar? *JURING: Journal for Research in Mathematics Learning*, *3*(2), 141–148.

Hogg, B.. Garfield, J., Schau, C., & Whittinghill, D. (2000). *Best practices in introductory statistics*. Retrieved from http://www.amstat.org/ education/pdfs/usei_l st.pdf.

Nguyen, H. H., & Tran, H. V. (2022). Digital society and society 5.0: Urgent issues for digital social transformation in Vietnam. *Jurnal Masyarakat, Kebudayaan, dan Politik*, *35*(1), 78-92.

Indrapangastuti, D., Surjono, H. D., & Yanto, B. E. (2021). Effectiveness of the blended learning model to ımprove students' achievement of mathematical concepts. *Journal of Education and e-Learning Research*, *8*(4), 423-430.

Jones, G. A., Thornton, C. A., Langrall, C. W., Mooney, E. S., Perry, B., & Putt, I. J. (2000). A framework for characterizing children's statistical thinking. *Mathematical Thinking and Learning*, *2*(4), 269-307.

Kartiko, I., & Mampouw, H. L. (2021). Pengembangan e-modul berbasis aplikasi Android pada materi perbandingan berbalik nilai. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *5*(2), 1700-1710

Komariah, S., Suhendri, H., & Hakim, A. R. (2018). Pengembangan media pembelajaran matematika siswa SMP berbasis Android. *JKPM: Jurnal Kajian Pendidikan Matematika*, *4*(1), 43.

Kuntze, S., Aizikovitsh-Udi, E., & Clarke, D. (2017). Hybrid task design: connecting learning opportunities related to critical thinking and statistical thinking. *ZDM - Mathematics Education*, *49(*6), 923–935.

Lailiyah, S., Kusaeri, & Rizki, W. Y. (2020). Identifikasi proses berpikir siswa dalam menyelesaikan masalah aljabar dengan menggunakan representasi graf [identifying students' thinking in solving algebraic problems using graph representations]. *Jurnal Riset Pendidikan Matematika*, *7*(1), 25–44.

Lapitan, L. D., Tiangco, C. E., Sumalinog, D. A. G., Sabarillo, N. S., & Diaz, J. M. (2021). An effective blended online teaching and learning strategy during the Covid-19 Pandemic. *Education for Chemical Engineers*, *35*, 116–131.

Lizarelli, F. L., Antony, J., & Toledo, J. C. (2020). Statistical thinking and its impact on operational performance in manufacturing companies: An empirical study. *Annals of Operations Research*, *295*(2), 923–950.

Makmuri, Wijayanti, D.A., Salsabila, E., Fadillah, R. N., 2021 Pengembangan aplikasi pembelajaran matematika berbasis android dengan pendekatan kontekstual pada materi persamaan garis lurus untuk peserta didik kelas VIII. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *5*(1), 643-654.

Marlissa, I., & Widjajanti, D. B. (2015). Pengaruh strategi REACT ditinjau dari gaya kognitif terhadap kemampuan pemecahan masalah, prestasi belajar dan apresiasi siswa terhadap matematika. *Jurnal Riset Pendidikan Matematika*, *2*(2), 186-196.

Martadiputra, B.A.P. (2012). *Meningkatkan kemampuan berpikir statistik mahasiswa S1 Pendidikan matematika melalui pembelajaran meas yang dimodifikasi*. (Doctoral dissertation, Universitas Pendidikan Indonesia).

Meylasari, N. D., Sujadi I., Subanti, S. (2020). The profile of 8th grader's level of statistical thinking: A case of analyzing and interpreting data. *Journal of Physics: Conference Series IOP Publishing 1796*(1),012052.

Mooney, E. S. (2002). A framework for characterizing middle school students' statistical thinking. *Mathematical Thinking and Learning*, *4*(1), 23–63.

Mooney, Edward S. (2002) A framework for characterizing middle school students' statistical thinking. *Mathematical Thinking & Learning*, *4*(1), 23.

Mooney, E., Hofbauer, P., Langrall, C., & Johnson, Y. (2001). *Refining a framework on middle school students statistical thinking*. Proceedings of the *23 rd Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education.* United States, Utah.

Muyaroah, S., & Fajartia, M. (2017). Pengembangan media pembelajaran berbasis Android dengan menggunakan aplikasi adobe flash CS 6 pada mata pelajaran biologi. *Innovative Journal of Curriculum and Educational Technology*, *6*(2), 22-26.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston VA: Author

Nurjanah, Dahlan, J. A., & Wibisono, Y. (2021). The effect of hands-on and computer-based learning activities on conceptual understanding and mathematical reasoning. *International Journal of Instruction*, *14*(1), 143– 160

Nurwita, F., Kusumah, Y. S., & Juandi, S. (2023). Pengembangan media pembelajaran berbasis aplikasi android untuk meningkatkan keterampilan pemecahan masalah matematika siswa SMP pada Teorema Pythagoras. *AIP Conference Proceedings, 2734*, 090059.

Putrihapsari, R., & Fauziah, P. Y. (2020). Manajemen pengasuhan anak usia dini pada ıbu yang bekerja : Sebuah studi literatur. *VISI : Jurnal Ilmiah PTK PNF*, *15*(2), 127–136.

Rismayanti, T. A., Anriani, N., Sukirwan. (2022). Pengembangan e-modul berbantu kodular pada smartphone untuk meningkatkan kemampuan berpikir kritis matematis siswa SMP. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *6*(1), 859-873.

Setiawan, A. A., Muhtadi, A., & Hukom, J. (2022). Blended learning and student mathematics ability in Indonesia : A meta- analysis study. *International Journal of Instruction*, *15*(2), 905–916.

Sopamena, P., Nusantara, T., Irawan, E. B., Sisworo, & Wahyu, K. (2018). Students' thinking path in mathematics problem-solving referring to the construction of reflective abstraction. *Beta: Jurnal Tadris Matematika*, *11*(2), 156–166.

Sugiono, S.(2020). Industri konten digital dalam perspektif society 5.0 (digital content industry in society 5.0 perspective). *Jurnal Ilmu Pengetahuan dan Teknologi Komunikasi, 22*(2),175-191.

Suhandri, S., Nufus, H., & Nurdin, E. (2017). Profil kemampuan koneksi matematis mahasiswa dalam menyelesaikan masalah matematika berdasarkan level kemampuan akademik. *Jurnal Analisa*, *3*(2), 115–129.

Tanmau, S. D., Ekowati, C. K., Nenohai, J. M. H. (2023). Pengaruh penggunaan media pembelajaran matematika berbasis Android terhadap hasil belajar materi teorema pythagoras pada siswa kelas VIII SMP negeri 1 amabi oefeto. *Haumeni Journal of Education*, *3*(2), 56-62

Ulusoy, C.K., & Mesture, K.A. (2017). Analyzing the statistical reasioning levels of preservice elementry school teachers in the context of model electing activity. *International journal of Research in Education and Science*, *3*(1), 20-30.

Author Information

Sardin Sardin
Universitas Pendidikan Indonesia
Jl. Setiabudi No. 229, Isola, Sukasari, Bandung, Jawa Barat 40154, Indonesia
Contact e-mail:*sardin23.pmat@upi.edu*

Martadiputra BAP
Universitas Pendidikan Indonesia
Jl. Setiabudi No. 229, Isola, Sukasari, Bandung, Jawa Barat 40154, Indonesia

Andika Pratama
Universitas Pendidikan Indonesia
Jl. Setiabudi No. 229, Isola, Sukasari, Bandung, Jawa Barat 40154, Indonesia

To cite this article:

Sardin, S., Bap, M., & Pratama, A. (2024). Use of android-based e-modules for statistical thinking abilities. *The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM), 27*, 155-163.