Research Article

Ez-CVal: Auto Generation of Critical Values

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Abstract: *Critical values play an important role in hypothesis testing and confidence interval. Failure to read the critical values from a statistical table will lead to the wrong answer. One way to overcome this problem is by implementing interactive teaching styles. Advances in digital technologies provide support for ensuring educators have effective pedagogical tools and resources. Thus, an innovation that offers engaging tools can be used in the classroom to empower students' learning capabilities. However, an unreliable internet connection may ruin the learning process if online-based teaching tools are used in a physical classroom with a poor internet connection. Based on these factors, Ez-CVal was developed as a teaching and learning tool that can help educators create an immersive learning experience for students. With Ez-CVal, critical values can be generated automatically. Hence, the confidence interval can be constructed correctly, and the decision-making in hypothesis testing can be done more efficiently. Ez-CVal can be accessed via electronic mobile devices such as laptops. The design of this product was made to be user-friendly and easy to operate. This product also takes into account the aesthetic elements, where the colours can be provided according to the user's preference. Another uniqueness of this product is that it is an offline-based digital teaching tool that can be accessed without having to use the internet or have any additional software installed. Ez-CVal is expected to have a potential commercial value and can be used as a digital tool in teaching and learning statistics courses in any higher education institution.*

Keywords: critical values; hypothesis testing; confidence interval; digital tools; offline-based.

1. INTRODUCTION

Many students find learning statistics to be challenging and unpleasant (Ben-Zvi & Makar, 2016). Integrating technology in the delivery of learning content can benefit education by making it more fascinating and effective (Zhang, 2022). Due to the complexity of concepts in calculation subjects such as Mathematics and Statistics, transformation in students' learning landscapes allows students to visualise the learning contents easily, which helps them perform better academically (Krishnasamy, Ling, & Kim, 2020).

During the pandemic, the adoption of technology in education has hit its peak (Gause, Makgaola & Rakhudu, 2022). Educators around the world began to utilize innovative digital tools to transform their teaching methods. After almost two years of open distance learning (ODL), face-to-face learning (F2F) is finally allowed in 2022. Recent studies have shown interest in identifying the best teaching method to be applied during this new normal period. Comparison between online and offline media shows that, most respondents preferred offline media and considered offline class more effective compared to online class (Damayanti & Rachmah, 2020; Valentino et al., 2021).

With all the digital tools available that educators have developed to conduct ODL classes, once again internet accessibility and connectivity may be an issue during physical classrooms. This is due to the inefficient internet facility available around campus (Chung, Subramaniam, & Dass, 2020). Meanwhile, in an attempt to understand students' barriers to accessing online apps on campus, Loureiro et al., (2021) found that students tend to give up and skip using their apps because poor internet connectivity makes it excruciating to experience the page reloading. Therefore, University should seriously consider improving technological infrastructure to ensure successful mobile learning in higher education (Asio et al., 2021; Criollo-C et al., 2021).

2. PROBLEM STATEMENT

In a statistics course, critical values play an important role in hypothesis testing and confidence intervals. Finding critical values using statistical tables may confuse students because some statistical tables can be read based on the right-tail or the left-tail. Apart from that, the tail of the hypothesis testing is also confusing, where the significance level should be divided into two when performing the two-tailed test. Failure to find the correct critical value for hypothesis testing would lead to an incomplete answer or the wrong decision.

One way to overcome this problem is by implementing interactive teaching styles. Advances in digital technologies provide support for ensuring educators have effective pedagogical tools and resources. Thus, an innovation that offers engaging tools can be used in the classroom to empower students' learning capabilities. However, an unreliable internet connection may ruin the learning process if online-based teaching tools are used in a physical classroom with a poor internet connection.

Digital tools that can be used to generate critical values automatically without the need for statistical tables are still absent from the literature. Determining critical values manually from the statistical tables involves a complex procedure. In fact, many tutorials on how to accurately read the statistical tables are widely discussed on various YouTube channels. With the help of these tutorials, in addition to guidance from the lecturer, students may learn how to read the statistical tables correctly. However, internet connectivity limitations within campus make it hard to frequently get access to information from the internet. In accordance with the statement, we decided to develop a digital tool that is user-friendly, quick, and easy to use, plus it can operate in offline mode.

3. OBJECTIVES

The main objective of this project is to develop a digital tool that can automatically generate critical values, to provide an interactive classroom tool useful for hypothesis testing and constructing confidence intervals that can be accessed in offline mode, to help students check the critical values they obtained from statistical tables, and to assist researchers in finding the critical values and deciding whether or not to reject the null hypothesis if the test statistics is used as a criterion for decision making.

4. PRODUCT DESCRIPTION

Ez-CVal is a digital tool developed to automatically generate critical values. This is to ease the process of finding critical values without using statistical tables. The three main characteristics of Ez-CVal are that it is easy to use, time-saving, and offline-based. Without having to install any additional software, users can get the critical values for all four important distributions by key in the significance level, choosing the tail of the test, and entering the degree of freedom if required. All four distributions can be shown on one slide of a PowerPoint presentation, and the slide can be copied and pasted onto

the instructor's or lecturer's slide presentation for hypothesis testing and confidence interval topics, or for any research course. Meanwhile, for aesthetic effect, users can also select the slide's colours based on their preferences while purchasing Ez-CVal.

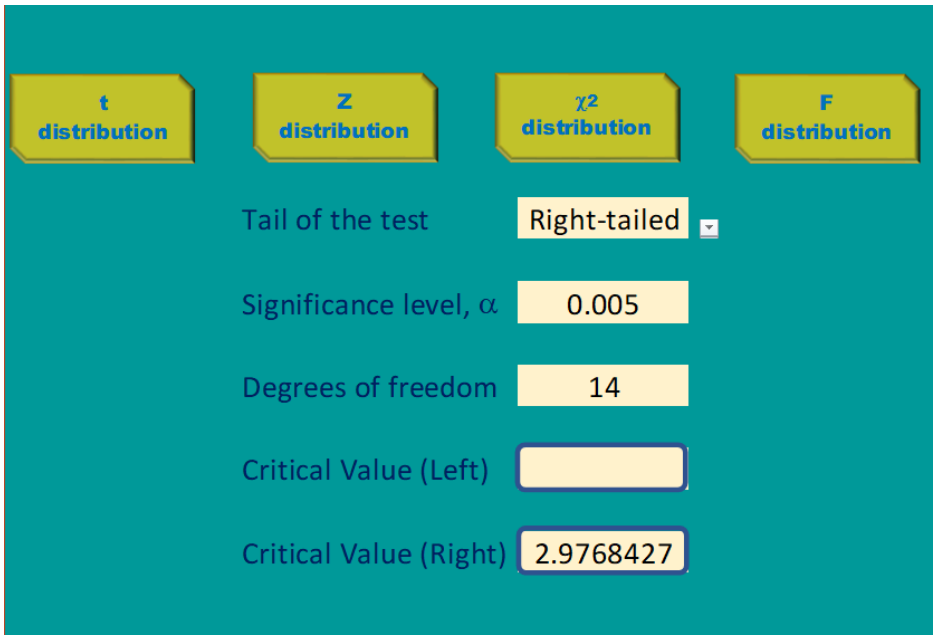

Figure 1: Main interface of Ez-CVal.

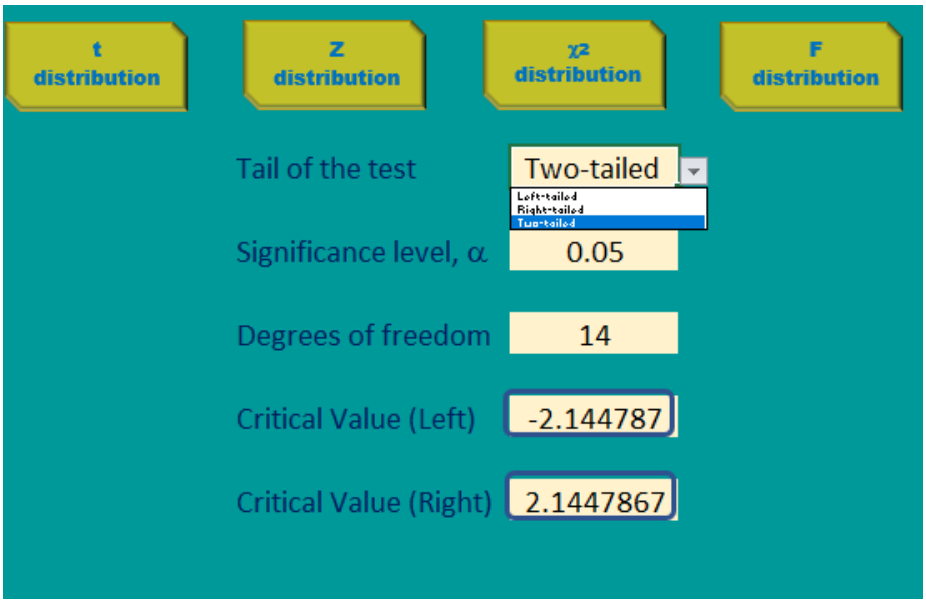

Figure 2: Critical value for t

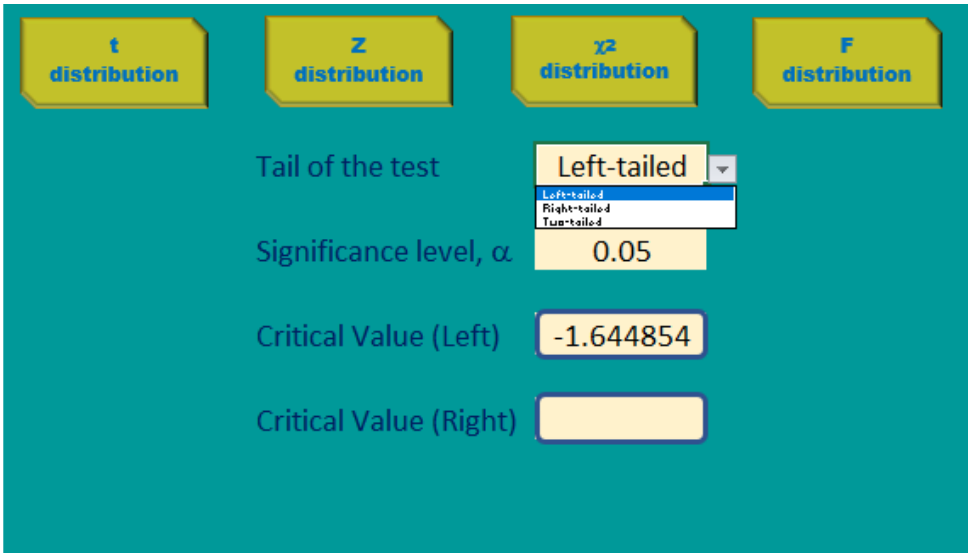

Figure 3: Critical value for z

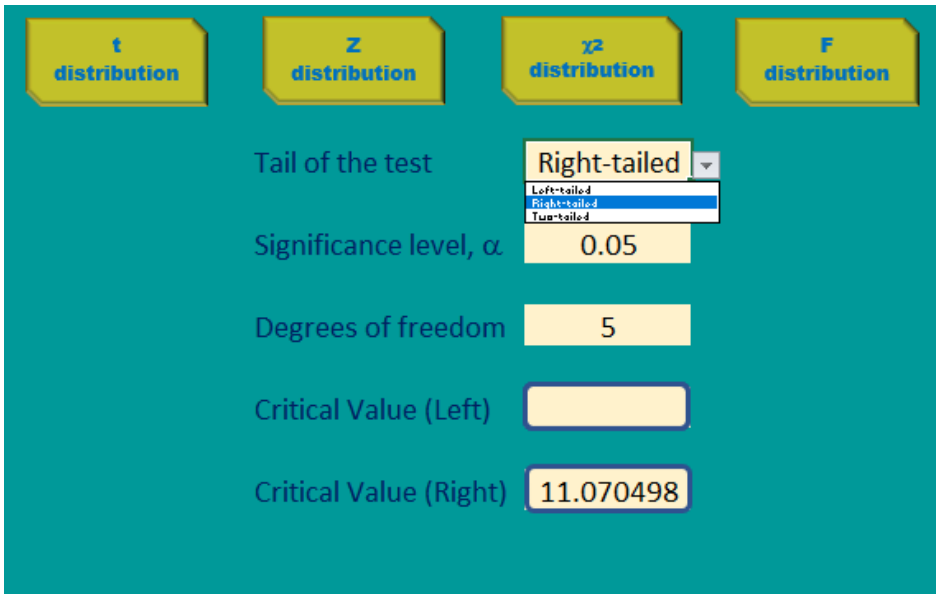

Figure 4: Critical value for χ^2

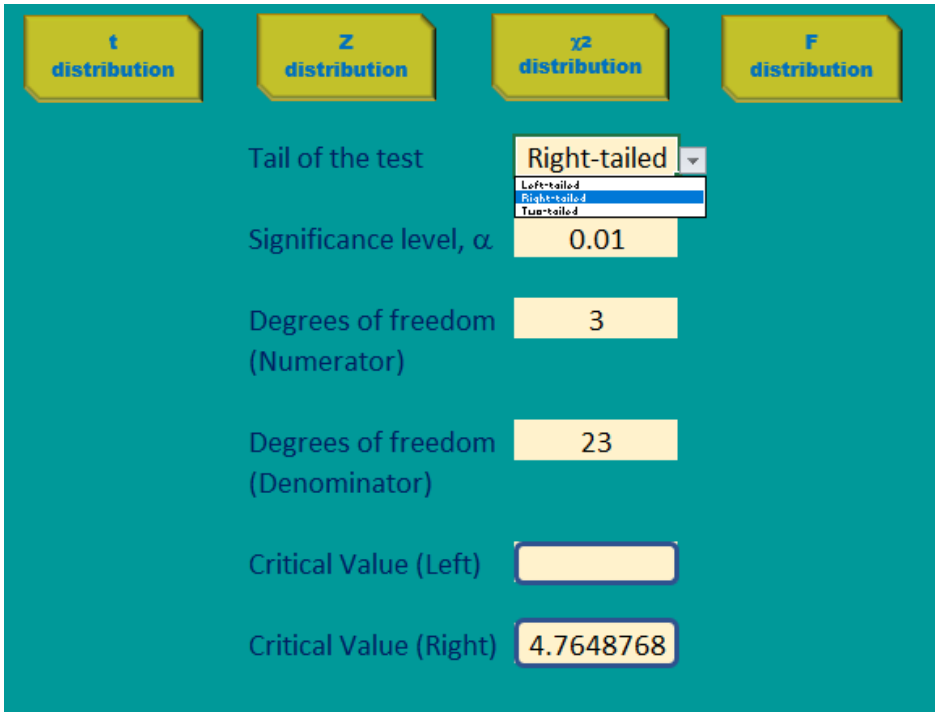

Figure 5: Critical value for F

Figure 1 shows the main interface of Ez-CVal. It can be seen that all the distributions for t, Z, χ^2, and F are displayed in one PowerPoint slide presentation. Critical values for t can be generated automatically after the users click the t distribution button, select the tail of the test, and enter the values of significance level and degrees of freedom as shown in Figure 2. Figure 3 shows that when the users click the z-distribution button, select the tail of the test, and enter the value of the significance level, the critical values for z will appear automatically. Figure 4 shows that the critical value for χ^2 can be easily obtained when the users select the χ^2 button, select the tail of the test, and enter the significance level and its degree of freedom. The critical value for F can also be easily obtained after selecting the F distribution button, entering the level of significance, and the degrees of freedom for the numerator and denominator, as shown in Figure 5.

5. BENEFIT AND NOVELTY OF Ez-CVal

The positive impact of switching to paperless teaching tools not only benefits the environment but also makes the accessibility of information quick and easy. Users do not need to purchase any statistical tables if they are only interested in the four common distributions. Overall, having a digital tool for finding critical values is more convenient, reduces costs, and is eco-friendly all at the same time.

The novelty of Ez-CVal is that it can be utilised on electronic mobile devices such as laptops. The design of this product was made to be user-friendly and easy to operate. This product is also provided in different colours to suit the user's preferences. It can be kept in both cloud storage and hard drives such as Google Drive, Pendrive, and others since Ez-CVal requires a very low storage capacity, which is only 80 KB.

Another uniqueness of this product is that the critical values for all four distributions can be obtained on only one slide of a PowerPoint presentation since the product of EZ-CVal is embedded on one PowerPoint slide. The slide can then be copied and pasted into the lecture slides easily. The lecturer can simply open it and show the critical value to the student by selecting the tail of the test and entering

the significance level and degrees of freedom if required, so that the students can immediately compare their critical value with the one obtained from the statistical table.

Furthermore, students can also utilize Ez-CVal to monitor their own mistakes in extracting the critical value from the statistical tables when working independently outside the classroom. This can boost students' confidence levels and motivation in learning statistics courses, consequently producing a positive impact on their grades.

Meanwhile, the distinctiveness of Ez-CVal compared to other alternative interactive products is that it is an offline-based tool that can be opened on any device that has Microsoft Office. This allows Ez-CVal to be used anytime and anywhere without forcing users to constantly rely on an internet connection.

6. COMMERCIALIZATION

The Ez-CVal has the potential to be commercialized through online shopping platform such as Shopee and Lazada. These are the perfect place to approach potential customers from thousands of users of that platforms. EZ-CVal has been registered under the intellectual property (LY2022S04823).

7. CONCLUSION

One of the interesting features of Ez-CVal is that it is an offline-based tool. This product was developed to resolve the issues related to the limited availability of internet connections in physical classrooms or offices that experience slow internet speeds. Using Ez-CVal, work productivity can be maintained even without internet access, because this product can be accessed anytime, anywhere, and while users are offline.

References

Asio, J. M. R., Gadia, E., Abarintos, E., Paguio, D., & Balce, M. (2021). Internet Connection and Learning Device Availability of College Students: Basis for Institutionalizing Flexible Learning in the New Normal. *Studies in Humanities and Education, 2*(1), 56–69. https://doi.org/10.48185/she.v2i1.224

Ben-Zvi, D., & Makar, K. (2016). International Perspectives on the Teaching and Learning of Statistics. In: Ben-Zvi, D., Makar, K. (eds). *The Teaching and Learning of Statistics.* Springer, Cham. https://doi.org/10.1007/978-3-319-23470-0_1

Chung, E., Subramaniam, G., & Dass, L. C. (2020). Online Learning Readiness Among University Students in Malaysia Amidst Covid-19. *Asian Journal of University Education, 2*(16), 46–58. https://doi.org/10.24191/ajue.v16i2.10294

Criollo-C, S., Guerrero-Arias, A., Jaramillo-Alcázar, Á., & Luján-Mora, S. (2021). Mobile Learning Technologies for Education: Benefits and Pending Issues. *Applied Sciences, 11,* 4111. https://doi.org/10.3390/app11094111

Damayanti, F. L. & Rachmah, N. (2020). Effectiveness of Online vs Offline Classes for EFL Classroom: A Study Case in a Higher Education. *Journal of English Teaching, Applied Linguistics and Literatures, 3*(1), 19–25.

Gause, G., Mokgaola, I. O., & Rakhudu, M. A. (2022). Technology usage for teaching and learning in nursing education: An integrative review. *Curationis*

Krishnasamy, S., Ling, L., & Kim, T. (2020). Improving Learning Experience of Probability and Statistics Using Multimedia System. *International Journal of Emerging Technologies in Learning, 15*(1), 77-87.

Loureiro, S. F., Pulvers, K., Gosdin, M. M., Clift, K., Rice, M., & Tong, E. K. (2021). The Development of a Web-Based Tobacco Tracker Tool to Crowdsource Campus Environmental Reports for Smoke and Tobacco–Free College Policies: Mixed Methods Study. *Journal of Medical Internet Research, 23*(10). https://doi.org/10.2196/26280

Valentino, V. H., Satria Setiawan, H. S., Tri Habibie, M., Ningsih, R., Katrina, D., & Syah Putra, A. (2021). Online And Offline Learning Comparison in the New Normal Era. *International Journal of Educational Research & Social Sciences, 2*(2), 449–455. https://doi.org/10.51601/ijersc.v2i2.73

Zhang, W. (2022). The Role of Technology-Based Education and Teacher Professional Development in English as a Foreign Language Classes. *Frontiers in Psychology, 13*, 910315. https://doi.org/10.3389/fpsyg.2022.910315