



AFRICAN JOURNAL OF THEORY AND PRACTICE OF EDUCATIONAL ASSESSMENT (AJTPEA)

Hard Print ISSN: 2545-5834
e-Print ISSN: 2992-362X

VOL. 12, JUNE, 2023

Artificial Intelligence Tools Used in Classroom Assessment

P. S. Iorkyaan

E. I. Aza

U. Enape

C. A. Nwankwo

iorkyaanp@gmail.com

iorememberaza@gmail.com

enapeu@gmail.com

chioma.nwankwo.pg93795@unn.edu.ng

Department of Science Education, Faculty of Education, University of Nigeria, Nsukka

Abstract

Artificial intelligence (AI) is transforming education by enhancing teaching and learning through the use of advanced technology. AI-driven educational assessment tools offer advantages such as more accurate and efficient assessments, personalized feedback for students, and adaptable teaching methods for educators. This paper examines the use of AI tools in classroom assessment, including digital assessment tools, formative assessment tools and classroom response systems, using software such as Edulastic, Exam View, Mentimeter, Socrative and Top Hat, for tasks like grading, identifying at-risk students and automatic performance assessment. It also assesses the role of teachers in AI-based classroom assessment. The utilization of AI in classroom assessment has both benefits and limitations, making collaboration among educators, policymakers and stakeholders crucial to maximize AI's advantages and minimize associated risks. Finally, the application of AI tools in classroom assessment can transform education, improve learning outcomes and prepare students to succeed in today's society.

Keywords: *Artificial intelligence, classroom assessment, tools.*

Introduction

With the introduction of computer science and computational technologies in schools, automatic, adaptive, and efficient AI technologies have been widely applied in various academic fields. Artificial Intelligence in Education (AIED), as an interdisciplinary field, emphasizes applying AI to assist instructor's instructional process, empower student's learning process, and promote the transformation of educational system (Chen, Lin & Cheng, 2020). Artificial intelligence in education has the potential to enhance instructional design and pedagogical development in the teaching processes through monitoring and tracking students' learning (Berland, Baker & Blikstein, 2015), predicting at-risk students (Hellings & Haelermans, 2020) and accessing students' performance automatically (Zampiroli, BorovinaJosko & Venero, 2021).

Artificial intelligence (AI) is a multidisciplinary field of computer science that aims to create intelligent machines capable of imitating human cognitive functions. Artificial Intelligence can augment human capabilities, enabling scientists, engineers, mathematicians and others to solve complex problems more effectively and drive innovation (Brynjolfsson & McAfee, 2017). At its core, AI focuses on developing algorithms, systems, and technologies that enable computers to perceive their environment, reason about it, learn from experiences and make decisions in a way that emulates human intelligence. As indicated by Jurafsky and Martin (2020), the field of AI encompasses a range of methodologies and application areas which include machine learning (ML), natural language processing and robotics.

Machine learning involves training computers to recognize patterns in data and make predictions or decisions based on that knowledge. According to Shu and Ye (2023), machine learning refers to the process in which computer systems use computer science and statistical techniques to progressively improve their performance on data analytical tasks by learning from data. The author further explained that machine learning builds models and algorithms by learning and improving from data. Shu and Ye highlights two main types of tasks in Machine learning: supervised learning and unsupervised learning. According to the authors, the main difference between these two types of machine learning is that supervised learning starts with knowledge of the output values. In contrast, unsupervised learning does not have explicit outputs to predict. Supervised learning aims to find and learn a computational function that best approximates the relationship between attributes and the outcome variable in the data. While unsupervised learning does not have explicit outputs to predict, and its objective is to infer and reveal the hidden structure in data (Shu 2020). Natural Language Processing on the other hand enables computers to understand, interpret, and generate human language, facilitating communication and interaction between humans and machines. Robotics, however, involves designing, building, and programming mechanical devices (robots) to perform tasks autonomously or semi-autonomously, often with the aim of automating repetitive or dangerous jobs. Wardat, Tashtoush, and Alali, (2023) assert that AI encompasses the development of intelligent robots capable of emulating human thought processes and actions, as such finding utility in diverse areas like medical diagnosis, self-driving cars, and education, among others. AI-powered tools and applications are now being used in many industries (Suh & Ahn, 2022), including education, to enhance the quality of services provided to students and teachers.

Interest in AI applications for education is rapidly growing and increased interest is being shown in its applications for classroom assessment. Classroom assessment refers to the process in which teachers and students gather, interpret and use evidence of student learning for a variety of purposes, including diagnosing students' strengths and weaknesses, monitoring students' progress toward meeting desired levels of proficiency, assigning grades, and providing feedback to parents" (McMillan, 2018). Various AI-powered tools such as digital assessment tools, formative assessment tools and classroom response systems among others can help to improve classroom assessment using software like Edulastic, Exam View, Mentimeter, Socrative and Top Hat among others. These tools provide educators with valuable knowledge of students' performance, learning outcomes, and instructional effectiveness. For instance, AI-powered formative assessment tools can analyze student responses to assignments and provide individualized feedback which help teachers identify areas of students' strengths and weaknesses (Nazaretsky et al., 2022). These AI tools can also provide teachers with insights into the effectiveness of their instruction and identify areas where they may need to adjust their teaching strategies while teaching in the classroom.

AI-powered tools can also help automate many aspects of classroom assessment processes, saving time and reducing the burden on teachers. Huang, Zou and Cheng (2023), opined that AI-powered grading tools can analyze students' essays and provide feedback on grammar, structure and content as well as reducing teachers' time grading assignments and class exercises. AI-powered tools can also help identify students at risk of falling behind or those that need remediation (Delgado, Azevedo & Sebastiany, 2020). These tools can analyze students' data, such as test scores and attendance records, and identify patterns that may indicate a need for intervention. This can help teachers to provide targeted support to students who need it most. Based on the above assertions, one could therefore say that Artificial Intelligence can enhance classroom assessment using software such as Edulastic, Exam View, Mentimeter, Socrative, Top Hat and many others for automated grading, providing real-time feedback and customizing learning materials to individual student needs, ultimately improving the classroom assessment process's efficiency and effectiveness.

Despite the potential benefits of integrating Artificial Intelligence (AI) into education, particularly in the realm of classroom assessment, challenges persist. Issues related to data privacy, bias, and the need for human oversight pose significant concerns. This, therefore, necessitates the need to examine the various application of AI tools in classroom assessment, highlighting the collaboration between AI and teachers and also addressing associated challenges and providing practical strategies to enhance AI utilization in education, particularly in classroom assessment.

Artificial Intelligence Software Used in Classroom Assessment

1. **Formative Assessment Tools:** These are AI classroom assessment tools that enable teachers to monitor students' learning in real-time, provide feedback, and adjust instruction based on their performance. It includes software like Mentimeter and Socrative.

- Mentimeter is a platform, without registration and it is free of charge; It allows the creation of surveys by including, first, the question and then the different answers among which the students must choose the correct one. It provides a management panel that makes possible any modification and from which you can also check the final results. It can be accessed through a computer or from a tablet or Smartphone. Mentimeter as a user-friendly web-based formative assessment tool is currently used by more than 8 million people (Little, 2016). Teachers, mainly, use it to ask questions to the students and take feedback from them anonymously through the internet during teaching. The questions, answers, and feedback from a session can be stored as data.

- Socrative is a free, online web platform for teachers to put questions to students through an app on their smartphone or tablet device. It has become widely used and is now the market leader of its type. Socrative simply provides the teacher with a new twenty-first century means of the age-old teaching technique of putting questions to students. Typically, a teacher using Socrative will bring up a test in the teaching room PC/screen, students will note the 'classroom' they must enter to access the test on their Socrative Student app (they do not need an account) and then proceed to answer the questions (Aslan & Seker, 2016). The teacher can decide to use Socrative for a 'Quick Question' within a classroom or pose several questions in a test at the end of teaching. The question format can be either multiple-choice or closed (true/false).

2. **Digital Assessment Tools:** Digital assessment tools provide teachers with the ability to assess student knowledge and skills using a variety of question types, including multiple-choice, short answer, and essay. It includes software like Edulastic and ExamView.

- Edulastic is another technological application for carrying out assessment systems. Through its different types of interactive and multimedia questions, the teacher can create online questionnaires which include additional content, both fixed (text, images or graphics) and moving (video). Edulastic also allows one to embed web links. Once the students finish answering the questions, the teacher receives the results immediately accompanied by a comparison with the established standards.
- Exam View is a comprehensive solution for creating, administering, and scoring tests. The software includes many features to save the teacher's time and generate information to assess and to improve students' performance. The Exam View allows the teacher to create tests, worksheets, or study guides while incorporating elements such as graphs, charts, pictures, and mathematical equations to assess the students. After creating a test, the teacher can print multiple versions, save the test for students to take over the LAN (Local Area Network), or use Exam View banks and the CPS clickers to quickly pre-assess or test students in a matter of minutes. According to Safitri, Efriyanti and Supriadi (2022), Exam View can also help teachers to create question banks and conduct assessments automatically.

3. **Classroom Response Systems:** Classroom response systems allow teachers to pose questions and to receive real-time student feedback using electronic devices. It includes software like Top Hat.

- Top Hat Classroom Response Systems are interactive teaching tools that enable real-time student engagement through polls, quizzes, and discussions, fostering active participation and feedback in educational settings. As indicated by Spencer, Sinno and Hatfield (2020), Top Hat has several unique question types and methods of displaying the responses given. These include displaying free-text responses in a word cloud format and a "click-on-target" question type that allows students to indicate their response by clicking on a location within an image. Responses for this latter question type are displayed in a heat map format. A discussion tool is also available, which allows students to respond, to read other students' responses in real time, and then to reply again if warranted. This feature also supports drawing-based responses. The variety of question types is very useful in keeping students engaged during classroom teaching sessions. This application has several advantages over systems that are limited to multiple-choice questions only.

Role of Teachers in Artificial Intelligence-Based Classroom Assessment

The significance of teachers in the context of classroom assessments through the integration of artificial intelligence (AI) cannot be overstated, even as the popularity of AI-based assessments grows for the swift and efficient assessment of students' learning. The transition from traditional to digital education as noted by Dillenbourg (2016), does not imply the redundancy of teachers; rather, it suggests a transformation in their role. Instead of debating the potential replacement of teachers by AI, Hrastinski et, al. (2019) acknowledged the benefits of AI and emphasized how these advantages can reshape the teacher's role in the classroom. In the realm of educational assessment, teachers continue to play a critical role in ensuring the appropriate utilization of AI for measurement and evaluation. This involvement encompasses various responsibilities such as:

1. **Designing assessment:** Teachers are tasked with designing classroom assessments and establishing learning objectives. Their comprehensive understanding of the curriculum and learning outcomes enables them to create classroom assessments that align precisely with these objectives.

2. **Providing context:** Teachers contribute contextual information to classroom assessment questions, thereby enhancing their relevance and significance. This approach increases student's engagement with classroom assessment and promotes a better understanding of its purpose.
3. **Interpreting results:** Despite the immediate feedback provided by AI-based classroom assessments, teachers are essential for interpreting results and offering actionable feedback to students. Their professional judgment allows them to evaluate student's responses and provides personalized feedback based on individual strengths and weaknesses.
4. **Continuous improvement:** Teachers utilize AI-based classroom assessment results to enhance their teaching practices. Through data analysis, they identify areas of weakness and adjust their teaching strategies to better meet the needs of their students.
5. **Ethical considerations:** Teachers are pivotal in ensuring the ethical use of AI-based classroom assessments. They must guarantee fairness, reliability, and validity in assessments, as well as the responsible protection and use of student data.
6. **Providing feedback:** In addition to automated feedback generated by AI, teachers supply extra feedback to students. This feedback is more personalized, as it aids students in understanding their strengths and weaknesses and in identifying areas for improvement.
7. **Individualizing instruction:** Teachers tailor instruction based on AI-based classroom assessment results, addressing the specific learning needs of each student. For instance, if a student struggles with a particular concept, the teacher can provide additional resources or collaborate with the student to develop a personalized learning plan.
8. **Monitoring progress:** AI-based classroom assessments help teachers monitor student progress over time. By tracking performance trends, teachers can identify patterns and adjust their teaching strategies accordingly.
9. **Fostering critical thinking:** While designed to evaluate knowledge, AI-based classroom assessments can be employed by teachers to foster critical thinking skills. Through encouraging students to reflect on their responses and to analyze provided feedback, teachers contribute to the development of students' ability to think critically about their learning.
10. **Ensuring accuracy:** Finally, teachers play a vital role in guaranteeing the accuracy of AI-based classroom assessments. They are responsible for verifying the reliability and validity of data, ensuring the assessment measures what it intends, and rectifying any errors or inaccuracies in the assessment process.

Benefits of Artificial Intelligence-Powered Tools in classroom Assessment

The integration of Artificial Intelligence (AI)-powered tools in classroom assessment offers a range of benefits that positively impact the classroom assessment experience. These include:

1. **Efficiency and Speed:** AI-powered tools enable quick and efficient classroom assessment processes, providing timely feedback to both students and teachers. This speed enhances the overall efficiency of the assessment workflow.
2. **Personalized Learning:** AI tools can analyze individual student performance data, allowing for personalized learning experiences. Constructive feedback and recommendations cater for each student's strengths and weaknesses, facilitating targeted educational support.
3. **Immediate Feedback:** With AI, classroom assessments can provide instant feedback to students. This immediate feedback not only aids in understanding mistakes but also promotes continuous learning and improvement.

4. **Data-Driven Insights:** AI tools generate and analyze vast amounts of data related to student performance. This data-driven approach enables teachers gain insights into student progress, identifying areas of strength and weakness.
5. **Adaptive Learning Paths:** AI algorithms can adapt to the individual learning pace and style of each student. This adaptability ensures that students receive content and assessments suited to their unique needs, fostering a more effective learning environment.
6. **Objective Grading:** AI eliminates subjective biases in grading by applying consistent and objective criteria. This ensures fair and impartial evaluation, reducing the likelihood of grading discrepancies.
7. **Time Savings for Educators:** Automating routine tasks such as grading and data analysis enables AI-powered tools to free up valuable time for teachers. This time-saving aspect allows teachers to focus more on instructional planning and individualized student support.
8. **Enhanced Accessibility:** AI-based assessments can be designed to accommodate different learning styles and abilities, promoting inclusivity in the classroom. Features such as text to speech or adaptive interfaces can benefit students with diverse needs.
9. **Continuous Monitoring and Feedback:** AI facilitates continuous monitoring of student progress, enabling ongoing assessment and feedback loops. This real-time information empowers teachers to intervene promptly when students encounter difficulties.

Challenges or Limitations in the Utilization of Artificial Intelligence-Powered Tools in Classroom Assessment

While the incorporation of AI-powered tools in classroom assessment offers several advantages in the assessment process, there are several challenges associated with their implementation. These include:

1. **Insufficient Stakeholder Involvement in AI Tool Development:** The absence of participation from key stakeholders in the development of AI tools for education poses a significant hurdle to successful AI adoption. When these tools are crafted without input from teachers, students, parents, and other stakeholders, they may not align with the specific needs of the education system. This lack of alignment can result in reduced relevance and hinder the adoption of AI tools in classrooms. According to Luckin and Cukurova (2019), AI developers often lack sufficient knowledge of learning sciences and a deep understanding of pedagogy, overlooking the expectations of teachers, who serve as the end-users of AI in education. Recognizing the pivotal role of teachers in AI-based education is crucial, necessitating consideration of their opinions, past experiences, and expectations for the successful integration of AI in schools (Holmes, Bialik & Fadel, 2019).
2. **Transparency Challenges:** A primary obstacle associated with AI in educational assessment lies in the lack of transparency in decision-making processes. Understanding how AI algorithms reach conclusions can be challenging, making it difficult for educators to evaluate the accuracy and fairness of assessments.
3. **Bias in AI Algorithms:** AI algorithms are susceptible to bias, leading to inaccurate and unfair assessments. The quality of AI systems relies on the data mined from training, and if this data is biased, the outcomes will also be biased.
4. **Reduced Human Interaction:** The integration of AI in educational assessment can diminish human interaction, adversely affecting students' learning experiences. Important cues and nuances that can only be discerned through human interaction may be overlooked by educators.
5. **Limited Assessment Scope:** AI-powered tools are typically designed to concentrate on specific assessment areas, primarily lower-order cognitive abilities such as knowledge and

comprehension. This specialization may render them unsuitable for assessing critical thinking, creativity, problem-solving, and other essential learning areas. Additionally, AI tools may lack the capability to measure affective attributes (e.g., feelings, attitude, interest, anxiety) and psychomotor skills, necessitating teachers to address these aspects and provide relevant feedback to the AI model.

6. Ethical Concerns: The utilization of AI in educational assessment introduces ethical concerns, including issues related to data privacy and ownership, as well as apprehensions about the potential replacement of human educators by technology.

Conclusion

The paper highlights the transformative potential of Artificial Intelligence (AI) in education, emphasizing its role in enhancing classroom assessment. AI-powered tools, such as formative assessment tools and digital assessment tools, offer efficiency, personalization, and immediate feedback, contributing to an improved learning experience. The integration of AI in education, however, presents challenges, including insufficient stakeholder involvement, transparency issues, and the potential for bias in algorithms. Despite these challenges, the paper highlights the crucial role of teachers in the integration of AI tools in classroom assessment, emphasizing their responsibilities in designing assessments, providing context, interpreting results, and ensuring ethical considerations. As AI continues to evolve, its application in education holds promise for advancing teaching practices and improving student outcomes, provided careful consideration is given to addressing associated challenges and involving educators in the development and implementation process.

Contribution of AI Classroom Assessment Tools to Literature

The study offers the following contribution of AI to literature;

1. The study offers a thorough examination of AI's involvement in diverse phases of test development, including test administration, scoring and result interpretation. This comprehensive overview provides educators, researchers, and policymakers with a deep understanding of the multifaceted impact of AI on the entire classroom assessment lifecycle.
2. An essential contribution lies in highlighting the collaboration between AI and teachers. The article explores the evolving role of educators in of AI-powered classroom assessments, emphasizing the need for a collaborative approach. This is invaluable for educators because it guides them in adapting teaching strategies to effectively use AI tools while attending to the unique needs of individual students.
3. Acknowledging the complexities associated with integrating AI into education, the article discusses potential challenges related to data privacy, bias, and the necessity for human oversight. By addressing these concerns, the work contributes to a better understanding of the risks involved. It also provides practical strategies to mitigate these challenges and offers directions for educators, policymakers, and stakeholders.
4. A distinctive contribution is the provision of practical strategies to address the identified challenges. These strategies serve as a guide for educators and policymakers, offering actionable insights into optimizing the use of AI in classroom assessment. By presenting solutions, the article aims to empower stakeholders in harnessing the benefits of AI in classroom assessment while minimizing potential risks.

Recommendations

The following recommendations have been made for mitigating the challenges experienced in the utilization of AI classroom assessment tools;

1. Formative assessment tools such as **Mentimeter** and **Socrative** should be implemented in classroom assessment in order gain knowledge about students' understanding through the use of interactive quizzes, polls, and Q&A sessions among others.
2. Bias mitigation strategies should be integrated by teachers in the use of AI tools during the classroom assessment process so as to ensure that assessments are fair and unbiased across diverse student populations.
3. Teachers should also be mindful of the value of human interaction in the learning process. Hence while AI can enhance efficiency, teachers should use it to complement the classroom assessment processes and not replace human involvement.
4. Teachers should augment AI tools with a comprehensive assessment approach by acknowledging the limitations of AI-powered tools in assessing higher-order cognitive abilities, affective attributes, and psychomotor skills. Hence teachers should be encouraged to supplement AI classroom assessments with other methods that capture a broader range of learning outcomes, ensuring a more comprehensive understanding of students' abilities.
5. Teachers should be mindful of the data privacy standards and ethical implications of using AI tools in the classroom.

References

- Aslan, B. and H. Seker (2016), 'Interactive Response Systems (IRS) Socrative application sample', *Journal of Education and Learning* 6, no. 1: 167–174. <https://doi.org/10.5539/jel.v6n1p167>
- Berland, M., Davis, D., & Smith, C. P. (2015). AMOEBA: Designing for collaboration in computer science classrooms through live learning analytics. *International Journal of Computer-Supported Collaborative Learning*, 10 (4), 425–447. <https://doi.org/10.1007/s11412-015-9217z>
- Brynjolfsson, E., & McAfee, A. N. D. R. E. W. (2017). Artificial intelligence, for real. *Harvard business review*, 1, 1-31.
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review.
- Delgado, H. O. K., de Azevedo Fay, A., Sebastiany, M. J., & Silva, A. D. C. (2020). Artificial intelligence adaptive learning tools. *BELT-Brazilian English Language Teaching Journal*, 11(2), e38749-e38749. <https://doi.org/10.15448/2178-3640.2020.2.38749>
- Dillenbourg, P. (2016). The evolution of research on digital education. *International Journal of Artificial Intelligence in Education*, 26(2), 544-560. <https://doi.org/10.1007/s40593-016-0106-z>
- Hellings, J., & Haelermans, C. (2020). The effect of providing learning analytics on student behaviour and performance in programming: A randomised controlled experiment. *Higher Education*, 83(1), 1–18. <https://doi.org/10.1007/s10734-020-00560-z>
- Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign. <https://curriculumredesign.org/wp-content/uploads/AIED-Book-ExcerptCCR.pdf>
- Hrastinski, S., Olofsson, A. D., Arkenback, C., Ekström, S., Ericsson, E., Fransson, G., Jaldemark, J., Ryberg, T., Öberg, L.-M., Fuentes, A., Gustafsson, U., Humble, N., Mozelius, P., Sundgren, M., & Utterberg, M. (2019). Critical imaginaries and reflections on artificial

- intelligence and robots in post-digital K-12 education. *Post-Digital Science and Education*, 1(2), 427-445. <https://doi.org/10.1007/s42438-019-00046-x>
- Huang, X., Zou, D., Cheng, G., Chen, X., & Xie, H. (2023b). Trends, research issues and applications of artificial intelligence in language education. *Educational Technology & Society*, 26(1), 112-131. [https://doi.org/10.30191/ETS.202301_26\(1\).0009](https://doi.org/10.30191/ETS.202301_26(1).0009)
- Ingraham, J., Garg, V., Barzilay, R., & Jaakkola, T. (2019). *IEEE Access*, 8, 75264–75278. <https://doi.org/10.1109/ACCESS.2020.2988510>
- Jurafsky, D. & Martin, J. H. (2020) *Speech and Language Processing*. <https://web.stanford.edu/~jurafsky/slp3/> [Accessed: 31 January 2023].
- Little, C. (2016) Technological Review: Mentimeter Smartphone Student Response System. Available at: < http://blogs.cardiff.ac.uk/learning-technology/wp-content/uploads/sites/286/2017/04/mentimeter_article.pdf > [Accessed: 5 March 2018]
- Luckin, R., & Cukurova, M. (2019). Designing educational technologies in the age of AI: A learning sciences-driven approach. *British Journal of Educational Technology*, 50(6), 2824-2838. <https://doi.org/10.1111/bjet.12861>
- McMillan, J. H. (2018). *Classroom assessment: Principles and practice that enhance student learning and motivation (7th ed.)*. Boston, MA: Pearson.
- Nazaretsky, T., Ariely, M., Cukurova, M., & Alexandron, G. (2022). Teachers' trust in AI-powered educational technology and a professional development program to improve it. *British Journal of Educational Technology*, 53(4), 914-931. <https://doi.org/10.1111/bjet.13232>
- Safitri, R. O., Efriyanti, L., Supriadi, S., & Okra, R. (2022). Hubungan Penggunaan Aplikasi Examview Dengan Kepraktisan Penilaian Hasil Belajar Di Smkn 4 Payakumbuh. *Koloni*, 1(3), 779-784.
- Shu, X. (2020). *Knowledge discovery in the social sciences: A data mining approach*. Univ of California Press.
- Shu, X., & Ye, Y. (2023). Knowledge Discovery: Methods from data mining and machine learning. *Social Science Research*, 110, 102817.
- Spencer, R., Sinno, J., Hatfield, K., Biderman, M., Doria, N., & Numer, M. (2020). Exploring top hat's impact on undergraduate students' belongingness, engagement, and self-confidence: A mixed methods study. *Journal of Research on Technology in Education*, 52(2), 197-215.
- Suh, W., & Ahn, S. (2022). Development and validation of a scale measuring student attitudes toward artificial intelligence. *Sage Open*, 12(2), 21582440221100463. <https://doi.org/10.1177/21582440221100463>
- Wardat, Y., Tashtoush, M. A., AlAli, R., & Jarrah, A. M. (2023). ChatGPT: A revolutionary tool for teaching and learning mathematics. *EURASIA Journal of Mathematics, Science and Technology Education*, 19(7), em2286. <https://doi.org/10.29333/ejmste/13272>
- Zampirolli, F. A., BorovinaJosko, J. M., Venero, M. L. F., Kobayashi, G., Fraga, F. J., Goya, D., & Savegnago, H. R. (2021). An experience of automated assessment in a large-scale introduction programming course. *Computer Applications in Engineering Education*, 29(5), 1284–1299. <https://doi.org/10.1002/cae.22385>

