International Journal of Multidisciplinary Research and Growth Evaluation.

Animation integration in teaching of physics and its effect on secondary school learners' academic performance in Makueni County, Kenya

Muinde NK [1*], Waititu MM [2], Oludhe DO [3]
[1] Department of Educational Communication and Technology, Kenyatta University, Kenya
[2-3] Senior Lecture, Department of Educational Communication and Technology, Kenyatta University, Kenya

* Corresponding Author: **Muinde NK**

Article Info

ISSN (online): 2582-7138
Impact Factor: 5.307 (SJIF)
Volume: 04
Issue: 06
November-December 2023
Received: 10-10-2023;
Accepted: 13-11-2023
Page No: 972-977

Abstract
This study investigated impact of instructional integration of animation on achievement in Physics of secondary school learners in Makueni County. Pre- and post-test quasi-experimental study design was used with two County schools, one for each of male and female students and two sub county (mixed) schools. The county schools do report better performance in Physics Kenya Certificate of secondary Education (KCSE) examination than the Sub-County schools, and generally the male students do outperform girls in the same examination in Physics. The study found that sub-county schools demonstrated comparable more gain in post-test performance than the County. It also emerged from the study that female students in county schools outshone their male counterparts by 1.827% in the post-test, while, in sub-county schools there was a 0.25% gap in favor of the girls. From these findings it is clear that the presumed underachievers, the female students, and the student in the sub-county schools gained more from instructional use of animations. However, the findings do not demonstrate any disadvantage of instructional use of animation towards county schools and the male students. Instructional use of animation therefore is useful in enhancing performance of otherwise presumed underachievers without any drawback to the presumed achievers.

Keywords: Physics education, Animation integration, Teaching, Learners, Performance

Introduction

The integration of animation in Physics instruction represents a promising avenue for enhancing pedagogical effectiveness. Research underscores that levering information and communication Technology (ICT), including animation, can revolutionize the educational landscape. Studies have shown that incorporating animated visuals aids in elevating student engagement, fostering critical thinking skills, and nurturing a deeper understanding of Physics concepts (Omondi, Odera, & Odhiambo, 2020) [19].

In the realm of Physics education, animation serves as a potent tool, complementing traditional teaching methods. By utilizing animated simulations and visualization, educators can bridge the gap between abstract theoretical concepts and tangible, comprehensible representations (Kaware & Sain, 2015). This utilization of animation technology is indispensable in modern educational contexts, where digital devices like computers, smartphones, and projectors have become ubiquitous (Patel & Mukwa, 1993) [21].

Nonetheless, challenges persist in ensuring widespread access to animation resources and equipping teachers with the necessary skills to effectively employ these tools. Despite the imperative to enhance digital competence among educators, the utilization of animation in Physics instruction often remains limited, primarily contained to teacher-centered approaches (Blikstad-Balas & Klette, 2020) [3]. Addressing this limitation necessitates comprehensive teacher training and the establishment of robust digital infrastructure (Khamidorich, 2020).

Empirical evidence suggest a significant correlation between students' access to ICT resources and their academic achievement while the availability of ICT resources at homes is inversely related to academic performance, the integration of animation and ICT resources within Physics classrooms positively influences students' academic progress (Hu, Gong, Lai & Leung, 2018; Kristiawan & Muhaimin, 2019) [13]. Thus, there exists a crucial disparity between the potential benefits of animation-infused Physics instruction and its current implementation in educational settings.

To narrow the gap, concerted efforts are needed to align pedagogical practices with the evolving digital landscape. Equipping educators with the requisite skills to harness the full potential of animation-enhanced learning environments can significantly enhance the quality of Physics instruction and student engagement.

Furthermore, in Africa, the integration of animation and ICT in Physics education is gaining momentum, recognized as a means to improve educational quality and accessibility (Tella, Ayen, & Popoola, 2017; Kimutai & changeiywo, 2018) [22, 12]. However, persistent challenges, such as inadequate infrastructure, continued investment and support in this endeavor.

In the realm of Physics education, animation plays a pivotal role, offering an engaging and dynamic avenue to convey complex concepts. While challenges like limited technology access and insufficient teacher training pesist (Asoro, 2021) [2], it's crucial to recognize that the fusion of animation and education can yield remarkable benefits. Research underscores that integrating technology, particularly animation, enhances students learning outcomes in subject such as mathematics and science (Mwathi, Gachago, & Keengwe, 2020; Omondi, Odero, & Odhiambo, 2020) [19, 17]. To fully harness the benefits of technology, especially animation in education, a multifaceted approach is essential. This approach should address not only the promising outcomes but also the persistent obstacles. Research emphasize the importance of comprehensive teacher preparation and robust ICT infrastructure for effective technology integration (Ng'eno, 2013) [18].

In today's educational, educators must become adept facilitators of technology-driven learning experiences. Adequate teachers' preparation ensures that educators possess both pedagogical skills and technical competence to effectively utilize tools like animation in instruction (Ondigi, Makira & Kimemia, 2015) [20]. As technology continues to transform education, educators must not only understand these tools but also seamlessly integrate them into their teaching methods (Lei, Zhao, Liu, & Tan, 2021) [14]. Ultimately, animation emerges as a vital tool in bridging the gap between Physics instruction and student engagement underlining its significance in modern education.

Objective

1. To determine differential effectiveness of animation integration on achievement of learners in Physics based on school category.

Materials and Methods

The research in question employed a quasi-experimental design and adopted a mixed methods approach, integrating both quantitative and qualitative techniques to address its research inquiries. This comprehensive study took place in Makueni County, situated in the lower eastern region of Kenya. It shares its borders with Machakos County to the north, Kitui to the east, Kajiado to the west, and Taita Taveta to the south.

The study encompassed a sample size comprising six schools from a pool of 38 public schools within Kathonzweni Sub-County, Makueni County, Kenya. The data collection process encompassing pre- and post-tests.

In this study, we utilized inferential statistics for robust data analysis. The quantitative data underwent through scrutiny using the statistical package for social science (SPPS), Version 17.0. Our approach involved extracting Frequencies, means, and standard deviations to illustrate the nuanced findings of the research.

Research Findings and Discussions

The study on the incorporation of animated resources to enhance Physics education gathered comprehensive insights through a multifaceted approach. Data was collected from pre- and post-tests administered to students. The primary objectives was to elicit valuable feedback from students regarding the effectiveness of integrating animations into Physics instruction. The following concise summary presents the noteworthy findings.

Table 1: County School-Experimental and Controlled Groups (Boys analysis) Group Statistics

Group	N	Mean	Std. Deviation	Std. error mean	T-test
Exp. Grp	55	89.403	1.432	1.432	3.261
Contr. Grp	47	66.781	2.173	2.173	2.7843

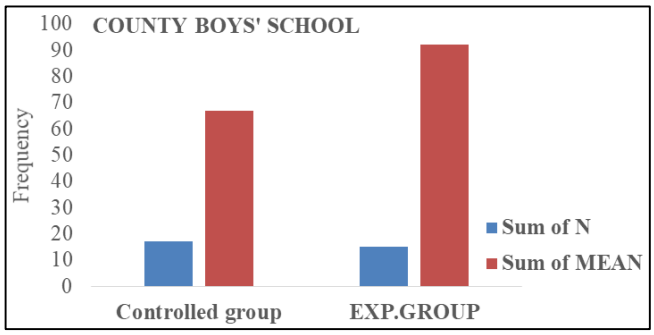

Fig 1: County Secondary School (Boys' Analysis)

County School - Experimental and Controlled Groups (Boys' Analysis)

In the analysis of County School (Boys' Analysis), a total of 102 students were divided into two groups: the experimental group (55 students) and the controlled group (47 students). The experimental group enjoyed a remarkable advantage as they were exposed to the innovative approach of animation integration. As a result, their mean score soared to an impressive 89.403, outshining the controlled group's average score of 66.781.

Notably, the experimental group's performance showcased not only higher academic achievement but also greater consistency, as indicated by smaller standard deviation of 1.432, compared to the controlled group's deviation of 2.173. These compelling results imply that animation integration had a profound positive influence on the boys' academic performance, setting them apart from their counterparts in the controlled group.

Table 2: County Girls Schools – Experimental Group and Controlled Group Group Statistics

Group	N	Mean	Std. Deviation	Std. error mean	t-test
EXP.GRP	35	91.23	8.172	1.4919	3.256
CONTR.GRP	27	64.20	15.397	2.811	2.8840

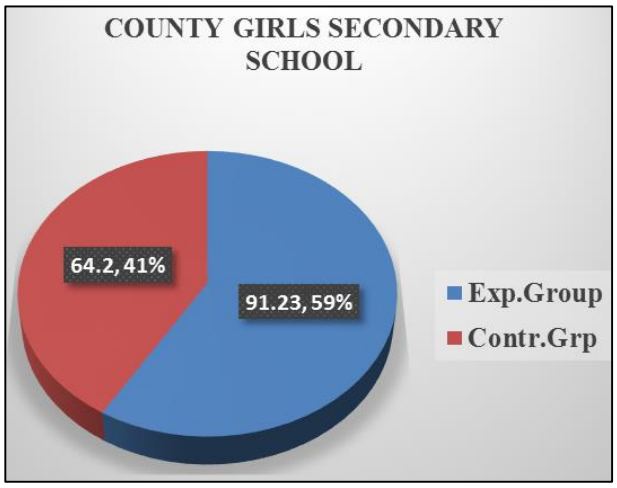

Fig 2: County girl's secondary school performance

The study conducted at County Girls secondary school aimed to examine the impact of integrating animation into the teaching of Newton's laws of motion on the achievement of learners in Physics, with a specific focus on gender differences. The research involved two groups: an experimental group and controlled group.

In the past, a group of 35 students was chosen as the experimental cohort. Before applying the treatment, a pre-experiment test was given to gauge their existing knowledge. Subsequently, a post-experiment test was conducted to assess their learning outcome after the intervention. The findings demonstrated a notable enhancement in the average score of the study. The results showed a significant improvement in the mean score of the experimental group (91.23), indicating that most students in this group achieved high grades. Moreover, the smaller standard deviation (8.172) suggested that the integration of animation positively influenced Physics performance, leading to more consistent results among the students.

On the other hand, the controlled group which followed traditional teaching methods, ad a lower mean score (62.20) and a larger standard deviation (15.397), indicating that the convectional pedagogy for teaching Newton's laws of motion was not as effective in promoting high performance.

An analysis using a t-test was carried out for both groups, which' resulted in a t-value of 3.256 and a p-value of 0.001 for the experimental group. As the p-value fell below the selected significance level (alpha), the null hypothesis was rejected, and the alternative hypothesis was accepted, suggesting a significance relationship between the integration of animation and Physics performance in secondary schools.

It is crucial to acknowledge that the effectiveness of animation integration might extend beyond gender differences and could benefit all students in their learning experience and academic achievements, however, this study specifically focused on examining gender differences as a particular aspect of its investigation.

Table 3: Comparison of Boys and girls performance

Group	Sum of N	Sum of pre-test	Sum of post-test	Sum of Deviation
County Boys	55	66.75	89.403	22.653
County Girls	35	64.2	91.23	27.03
Sub-County Girls	15	52.2	89.653	37.453
Grand Total	**105**	**183.15**	**270.286**	**87.136**

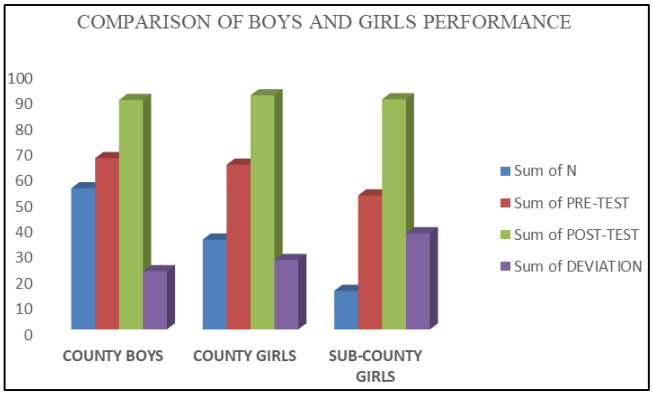

Fig 3: Comparison of boys and girls performance

A comprehensive study was conducted to assess the academic performance of male and female students in county schools and sub-county schools, particularly focusing on the integration of an animation model in teaching Newton's laws of motion. Notably, the findings revealed that girl's in sub-county schools, characterized by lower prior experiences, exhibited then greatest improvement. In comparison to boys in county schools, they outperformed by 0.25%, demonstrating a substantial positive deviation of 37.453% from pre to post-test. This underscores the efficacy of incorporating visual cues through animation in enhancing learning outcomes.

Furthermore, girls in county schools also demonstrated noteworthy progress, surpassing their male counterparts by 1.827%. This considerable improvement was complemented by a positive deviation of 27.03%. The outcome align with Richard Mayer's contention that students excel when multiple modalities, particularly visual cues, synchronized in the learning process. The study highlights the distinct advantage of employing visual elements, such as animation models, in teaching, particularly for female students who exhibited enhanced learning outcomes in both sub-county and county school settings.

Moreover, this research sought to draw captivating comparisons between the perspectives schools categories when it comes to incorporating animations. The intriguing findings have been beautifully illustrated in Figure 1.4

Table 4: Performance of the Schools

Group	N	Mean
County boys' school	55	89.403
County girls' school	35	91.23
Mixed Sub-county school	21	89.653

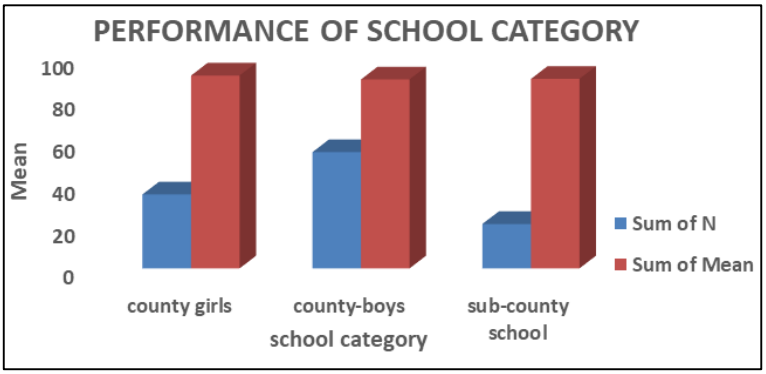

Fig 4: Performance of the school category

The study had the objective of examining how the inclusion of animation in Physics instruction could affect academic achievement in students from various school settings, with a particular emphasis on Newton's laws of motion. The investigation utilized pre-examination and post-examination evaluation to collect data from two sets of schools: one that integrated animations in their teaching (experimental group) and another that did not (controlled group).

In the experimental group, the county boys' school achieved a mean score of 89.403%, while the controlled group scored an average of 66.78%. Similarly, the county girls' school attained an aggregate of 91.23% whereas their counterparts in their controlled group attained a mean score of 64.20%. Performance in the mix-day and boarding school in the experimental group achieved promising mean score of 89.653%, indicating that visual and auditory modalities together can positively impact their performance. While, controlled group managed a mean score of 54.2%.

The experimental groups demonstrated significant improvements in their score when animation model was incorporated in teaching Newton's laws of motion. This implies that the animation model positively impacted the students' performance in understanding these abstract concepts. Visualization of these concepts through mental images helped enhance both conceptual and procedural knowledge, enabling the students to integrates the two and solve problems accurately.

The performance gap between the county-boys' school and county girls' school in the experimental group was 1.827%. Considering that prior-experiences of these school categories are believed to be similar, such a small performance gap is expected. Notably, the girls benefited most, with 27.03% difference compared to the controlled county-girls' school. This clearing shows girls learn more effectively when visual and auditory modalities are used in teaching and learning, rather than relying solely on verbal instruction. In this category, the students' identified the gaps between conceptual and procedural knowledge, thanks to their ability to create mental images and visualize abstract concepts concretely. The students expressed satisfaction with their performance in Newton's laws of motion and believed they would perform better in their national examination.

The performance of sub-county mixed day and boarding school was not disappointing either. The experimental group managed 89.6% as the mean score. Since Animation model utilizes both visual and audio components simultaneously, students are able to visualize these abstract concept into concreteness. Consequently, they can establish correlations between conceptual and procedural knowledge, enabling them to solve problems accurately.

These results indicates that students' low prior-experiences can even perform better if provided with a conducive learning environment and if animation model are integrated into the teaching and learning of the Newton's laws of motion. The researcher established that sub-county mixed day and boarding school benefited the most from animation integration.

Conclusion

In conclusion, our study unequivocally substantiates Richard Mayer's multimodal learning theory (2009), emphasizing that students attains optimal learning outcomes when exposed to multiple sensory modes simultaneously. This ground breaking research not only affirms the academic capabilities of students in sub-county and county schools, showcasing their potential to perform on par with their peers in extra-county and national schools, but it also underscores the remarkable potential for female students to excel when animation is seamlessly integrated into their educational experience.

The infusion of animation into the teaching and learning of Newton's laws of motion yielded transformative results. It undeniably instilled a profound enthusiasm for Physics among students, fostering a positive attitude towards the subject matter. What's more, animation served as a powerful tool, translating intricate and abstract concepts within Newton's laws of motion into vivid and tangible visual representations, enhancing comprehension.

Notably, our research highlights the adeptness of teachers in effectively utilizing animation equipment and cultivating a favourable disposition towards its integration into Physics education. The unanimous testimony of the three participating teachers in the three experimental schools underscores the captivating nature of the animation model, ensuring that students remained engrossed in the instructional content throughout their lessons. This, in turn, effectively bridged the chasm between abstract theory and practical application, a critical revelation that aligns with previous research by Zerihum, Desta, and Shemelise (2020), shedding light on the deficiencies in conceptual and procedural understanding among pre-service Physics educators.

Most importantly, our study offers invaluable insight into revolutionary pedagogical methodologies for teaching and learning. Consequently, the integration of animation in Physics education should not merely be considered but enthusiastically embraced as a beacon of academic progress and students' engagement.

Acknowledgement

As a master's student at Kenyatta University, my experience was both amazing and challenging. Numerous individuals have played a significant role in shaping my academic journey over the years, and I am sincerely grateful for their invaluable assistance. I would like to take a moment to acknowledge and express my heartfelt appreciation to each and every one of them.

First and foremost, I express my deepest gratitude to my supervisor, Dr. Michael Waititu, for introducing me to the realm of research. His astute guidance, unwavering support, and amiable demeanor have all contributed to my ability to effectively complete my thesis. Additionally, I am thankful to him for granting me the additional time I required to finalize my research work.

Additionally, i would like to offer my heartfelt appreciation to Dr. David Oludhe Owour, my co-promoter, for his professional advice and unwavering support throughout my research. Our frequent interactions have provided me with a wealth of knowledge, and I am truly grateful for his contributions. Furthermore, I express my gratitude to the esteem committee members who made my defense both enjoyable and enlightening, offering invaluable advice along the way.

My deepest appreciation goes to my wife, Jacinta Nzula, my daughter, Yvette Mumbua, and my son, Fidel Kyama, for their constant support and patience during the arduous process of completing my research and preparing my thesis. Your unwavering prayers and words of encouragement have been my pillars of strength during challenging times.

Finally, but certainly not of lesser importance, I want to convey my deep thankfulness to God for guiding me through every obstacle and triumph. At every step of this journey, I have felt His guiding influence, and it is solely by His grace that I have accomplished my master's degree successfully. I will continue to place my faith in Him as I navigate future endeavors, knowing that His guidance will lead me to new heights.

In conclusion, I would like to express my genuine gratitude to each and every person involved for their unwavering support and contribution to my academic journey. The knowledge, guidance, and encouragement I have received from each of you have immensely enriched my experience at Kenyatta University, and iam confident that the lesson I have learned will continue to shape my future endeavors

References

1. Aina JK. Analysis of gender performance in physics in college of education-Nigeria, 2013.
2. Asoro RO. Challenges and strategies for implementing information and communication technology in Nigeria schools. Educ Inf Technol. 2021; 26(1):523-539. https://doi.org/10.13189/ujer.2018.060306.
3. Bliststad-Balas M, Klette K. Exploring technology use in teachers' everyday practice: A longitudinal study. Eur J Teach Educ. 2020; 43(4):586-601. https://doi.org/10.1080/02619768.2020.1815015.
4. Coward FL, Crooks SM, Flores R, Dao D. Examining the Effects of Gender and Presentation Mode on Learning from a Multimedia Presentation. Multidiscip J Gend Stud. 2012; 1(1):48–69.
5. Ellison G, Swanson A. The gender gap in secondary schools mathematics at high school achievement levels. J Econ Perspect. 2010; 24(2):109-128.
6. Hess TJ, Fuller MA, Mathew J. Involvement and decision-making performance with a decision aid: The influence of social multimedia, gender, and playfulness. J Manag Inf Syst. 2005; 22(3):15-54.
7. Hoe M, Toomey N. Learning with multimedia. The effect of gender type of multimedia learning resources and spatial ability. Comput Educ. 2020; 146:103747.
8. Hill H, Johnston A. Categorizing sex and identity from the biological motion of faces. Curr Biol. 2001; 11(11):880-885.
9. Hu W, Gong Y, Lai C, Leng H. Exploring the effects of home and school information and communication technology environment on students' reading literacy. Int J Educ Dev. 2018; 62:162-162. https://doi.org/10.1016j.ijedudev.2018.02.002.
10. Joensen S, Nielsen HS. Maths and gender. Is math's a rout to high-powered career? Discussion paper NO. 7164 January 2013. Denmark.
11. Khamidovich A. Developing a culture of self-regulated learning in mathematics challenges for teacher training in the digital age. J Educ Teach. 2020; 46(4):456-469. https://doi.org/10.1080/02607476.2020.1767262.
12. Kimutai G, Changeiywo JM. Factors affecting the integration of information communication technology in public secondary schools in Kenya. Universal J Educ Res. 2018; 6(3):484-491. https://doi.org/10.13189/ujer.2018.060306.
13. Kristiawan M, Muhaimin M. The effect of information and communication technology access and usage on student achievement. Evidence from Indonesia. Int J Emerg Technol Learn. 2019; 14(12):192-202. https://doi.org/10.399/ijet.xl4162-11542.
14. Lei J, Zhao Y, Liu Y, Tan X. Promoting technology integration in education. A meta-analysis of the effects of teacher professional development. Educ Technol Res Dev. 2021; 69(1):149-168.
15. Macharia C, Wachira PM. Digital learning initiative in Kenya. A critical review of selected projects and programs. Educ Inf Technol. 2019; 24(6):4097-4115. https://doi.org/10.1007/s10639-019-10023-x.
16. Mohamed AM, Mhamed B, Abdesselan B, Taontik H, El MA. The effect of using computer simulation on students' performance in teaching and learning Physics: are there any gender and area gaps. Int J Educ Res, 2021.
17. Mwathi JK, Gachago D, Keengwe J. Perception of educators on the use of mobile phones for teaching and learning in a resource-constrained higher education context in Kenya. Educ Inf Technol. 2020; 25(4):2647-2666. https://doi.org/10.1007/5/0639-019.
18. Ng'eno JK. Integration of information and communication technology in teaching and learning mathematics in secondary schools in Bomet district, Kenya. J Educ Pract. 2013; 4(2):67-77. https://file.eric.ed.gov/fulltext/Ej1061669.pdf.
19. Omondi FA, Odero FO, Odhiambo GO. Students' attitudes towards the use of Information Communication technology in mathematics in secondary schools in Kisumu, County, Kenya. J Educ Technol. 2020; 16(2):1-9. https://www.journalfeduration.net/index.php/ije/articles/view/1985.
20. Ondigi PM, Makira CM, Kimemia EW. Evaluation of information communication technology integration in teaching and learning. A case study of selected

secondary schools in Kisii County, Kenya. Int J Educ Res. 2015; 3(11):171-184.
21. Patel RA, Mukwa CN. Pre-service teacher training and the integration of information technology integration in classroom practice. Problems and possibilities. J Inf Technol Teach Educ. 1993; 2(3):391-402. https://doi.org/10.1080/0962029930020306.
22. Tella A, Ayeni CO, Popoola SO. Assessing the potentials of information and communication technology (ICT) utilization in teaching and learning in three selected higher education institutions in Ogun state, Nigeria. Int J Educ Dev Using Inf Commun Technol. 2017; 13(1):70-84. https://files.eric.ed.gov/fulltext/Eji137753.pdf.
23. Sanchez CA, Wiley J. Sex differences in science learning: Closing the gap through animations. Learn Individ Differ. 2010; 20(3):271-275.
24. Wong M, Castro-Alonso JC, Ayres P, Paas F. Investigating gender and spatial measurements in instructional animation research. Comput Human Behav. 2018; 89:446-456.
25. Yezierski EJ, Birk JP. Misconceptions about the particulate nature of matter. Using animations to close the gender gap. J Chem Educ. 2006; 83(6):954.
26. Zerihnu AC, Desta GS, Shemelise AA. Assessing students' factual, conceptual and procedural knowledge of Newton's laws of Motion, 2020 https://doi.org/10.21067/mpoj.v612.6664.