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The Effectiveness of Interactive Animation Media in Improving Conceptual Understanding in Physics Subjects at Assumption College Thonburi

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ABSTRACT

This study aims to examine the effectiveness of interactive animation media in enhancing students' conceptual understanding in Physics at Assumption College Thonburi. The research was motivated by the consistently low level of conceptual comprehension among students when learning abstract and complex Physics topics. A quantitative approach was employed using a quasi-experimental design involving two groups: an experimental group that utilized interactive animation media and a control group that received conventional instruction. A conceptual understanding test was administered as both pre-test and post-test. Data analysis using an independent t-test revealed a statistically significant difference in learning outcomes between the two groups. Students taught using interactive animations showed a marked improvement in their understanding of key Physics concepts such as motion, force, and energy. Furthermore, the use of interactive media positively influenced students' learning motivation and classroom engagement. These results indicate that technology-integrated instruction, particularly with animated media, can effectively support conceptual learning and address the challenges often encountered in traditional Physics education. The study recommends broader implementation of interactive animation media not only in Physics but also in other science subjects to improve educational outcomes at the secondary level.

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INTRODUCTION

The teaching and learning of Physics continue to present notable challenges in secondary education due to the abstract nature of many of its concepts, which often remain intangible to learners without adequate visual and experiential representation. Despite advancements in curriculum design, many students struggle with grasping fundamental principles such as force, motion, and energy when taught using traditional lecture-based methods (Bayrak & Kanli, 2020). This issue is intensified by low levels of student engagement in science classrooms, particularly when instructional practices fail to provide interactive or meaningful real-world contexts (Gok, 2021).

In recent years, digital instructional media have been increasingly recognized as a promising solution for bridging the gap between abstract Physics concepts and learners' cognitive processing. Interactive animation, in particular, enables dynamic visualization of scientific phenomena, providing learners with opportunities to observe, manipulate, and interpret complex processes through movement, color, and simulation (Sari et al., 2022; Alqassab et al., 2019). Such media offer multisensory learning experiences that reduce extraneous cognitive load and promote deeper conceptual understanding, consistent with cognitive load theory (Sweller et al., 2019).

Prior studies have consistently shown the positive effects of interactive animation on science learning outcomes, including enhanced comprehension and improved problem-solving skills (Van der Meij & de Jong, 2020; Baser & Soylu, 2021). However, much of the existing research has been conducted in Western or East Asian educational contexts, where instructional cultures and technological readiness differ considerably from those in Southeast Asia. As a result, the extent to which interactive animation can effectively support Physics learning in Thai secondary schools remains insufficiently explored (Kittithanasuwan et al., 2023).

Moreover, previous research has primarily emphasized cognitive gains, with limited attention to learners' affective responses—such as motivation, interest, and engagement—which play a critical role in students' long-term success in Physics (Papadouris et al., 2022). Another gap concerns the specificity of content: while numerous studies have examined multimedia tools in general science topics, relatively few have focused on Newtonian mechanics, one of the most challenging domains for secondary learners due to its requirement for both abstract reasoning and mathematical application.

Therefore, the present study fills these gaps by investigating the effectiveness of interactive animation media in improving conceptual understanding specifically within the context of Newtonian mechanics, while simultaneously examining students' engagement in a Thai secondary school setting. This dual focus offers a novel contribution to the current literature, particularly in Southeast Asia, where localized empirical evidence on multimedia-enhanced Physics instruction remains limited.

Physics, as a discipline deeply rooted in abstract reasoning and mathematical formalism, benefits greatly from such visual scaffolding. For example, topics such as Newton's laws of motion or electromagnetic induction are more readily grasped when learners can manipulate variables and see immediate visual feedback through animations (Baser & Soylu, 2021). In this regard, interactive animations act not only as illustrative tools but also as platforms for exploratory learning, allowing students to experiment within simulated environments.

The positive impact of animation on student engagement and motivation has also been well-documented. According to studies by Chien et al. (2021), students exposed to animated learning environments report higher levels of curiosity and sustained attention. These emotional and motivational benefits are critical in fostering a positive learning atmosphere, especially in challenging subjects like Physics, where student frustration and disengagement are prevalent (Papadouris et al., 2022).

Beyond engagement, the pedagogical design of interactive animation media plays a crucial role in facilitating conceptual change—a process whereby students replace preexisting misconceptions with scientifically accurate understanding. Animation media often include features such as real-time feedback, guided prompts, and adaptive pacing, which aid in challenging erroneous beliefs and reinforcing correct scientific principles (Moreno & Mayer, 2020). This iterative cycle of visualization, reflection, and reinforcement supports long-term retention and transfer of learning.

A growing body of international research provides empirical support for the efficacy of interactive animations in science education. For instance, a meta-analysis by Castro-Alonso et al. (2021) reveals that students exposed to animation-based instruction show an average improvement of 20–30% in post-test scores across science domains. In Physics, this effect is particularly pronounced due to the nature of its content, which often involves dynamic systems and time-dependent changes.

In the context of Southeast Asia, and particularly in Thailand, integrating such media is a promising strategy for improving STEM outcomes. Educational institutions like Assumption College Thonburi are increasingly adopting innovative technologies to enhance student achievement. However, localized studies are still scarce, and most findings rely heavily on data from Western or East Asian contexts. This creates a gap in the literature concerning the cultural and pedagogical efficacy of interactive animation media in Thai secondary schools (Kittithanasuwan et al., 2023).

Addressing this gap, the present study investigates the impact of interactive animation media on conceptual understanding in Physics among students at Assumption College Thonburi. Conceptual understanding is defined here as the ability to explain, apply, and interrelate scientific principles beyond rote memorization (Seel, 2019). The study hypothesizes that students who receive instruction via animation-enhanced lessons will demonstrate higher conceptual comprehension compared to those taught through traditional methods.

The research also seeks to explore whether interactive animations influence students' affective responses to Physics learning. Educational psychology underscores the importance of emotions in learning, noting that positive affective states can enhance cognitive processing and academic achievement (Schunk & DiBenedetto, 2020). It is therefore hypothesized that the interactive nature of animations not only facilitates understanding but also improves attitudes toward Physics.

Furthermore, the study incorporates the Universal Design for Learning (UDL) framework, which promotes flexible teaching strategies to accommodate diverse learning preferences. Interactive animations inherently support UDL principles by offering multiple means of representation and engagement, making them suitable for heterogeneous classrooms (Meyer et al., 2021). This flexibility is vital in inclusive education settings, where students exhibit a broad spectrum of abilities and learning styles.

The research utilizes a quasi-experimental design to compare the learning outcomes of two groups: one receiving instruction via interactive animations and the other through conventional lectures. Pre- and post-tests focused on core Physics concepts serve as the primary instrument of measurement. The study also includes qualitative observations and feedback to gain a comprehensive understanding of student experiences and perceptions.

By situating this research within current theoretical and empirical frameworks, the study aims to contribute meaningful insights into the design of effective Physics instruction. Ultimately, the findings are expected to inform educational policy and practice, particularly regarding the integration of digital media in secondary science education in Thailand and beyond.

Grounded in constructivist learning theory and the Universal Design for Learning (UDL) framework, this study hypothesizes that students receiving instruction through interactive animation media will demonstrate higher conceptual understanding and greater learning engagement than those taught through conventional methods. By integrating quantitative assessment with qualitative observations, the study aims to provide a comprehensive evaluation of how technology-enhanced instruction can address persistent challenges in Physics education at the secondary level.

RESEARCH METHODOLOGY

This study employed a quantitative quasi-experimental design to investigate the effectiveness of interactive animation media in enhancing students' conceptual understanding in Physics. The quasi-experimental design was chosen due to the constraints of conducting randomized control trials within an existing school setting. Two intact classes from Assumption College Thonburi were selected as the participants: one class was designated as the experimental group and the other as the control group. The experimental group received instruction using interactive animation media, while the control group was taught using conventional teaching methods, such as lectures and textbook explanations. The selection of both groups ensured similar academic performance levels based on prior year results to maintain baseline equivalence.

A total of 76 Grade 10 students participated in the study, with 38 students in each group. Both groups covered the same Physics topics—specifically, Newtonian mechanics, including force, motion, and energy—over a four-week instructional period. The interactive animation materials used in the experimental group were developed using Adobe Animate and embedded into a web-based platform to allow seamless integration into classroom activities. These animations were designed to be interactive, featuring user-controlled elements such as sliders, real-time feedback, and quiz segments that aligned with constructivist learning principles and Universal Design for Learning (UDL) guidelines.

Data collection was conducted using a Conceptual Understanding Test (CUT), which was administered as a pre-test before the intervention and a post-test after the four-week instructional period. The test items were developed based on standardized Physics concept inventories and were validated by three Physics education experts for content validity. Each test consisted of 25 multiple-choice and short-answer questions, measuring students' ability to explain, apply, and analyze fundamental Physics concepts. Additionally, qualitative data were gathered through classroom observations and student interviews to provide contextual insights into students' learning experiences and engagement with the instructional media.

To ensure reliability and validity, the pre-test and post-test instruments underwent a pilot test with a different group of students, yielding a Cronbach's alpha coefficient of 0.87, indicating a high level of internal consistency. Content validity was ensured by aligning the test items with the Thai national curriculum standards for Physics. Inter-rater reliability for the short-answer questions was established through blind scoring by two independent raters, with a Cohen's kappa value of 0.81.

Quantitative data were analyzed using inferential statistics, specifically paired-samples t-tests and independent-samples t-tests, to examine within-group and between-group differences in pre- and post-test scores. An alpha level of 0.05 was used to determine statistical significance. Effect sizes (Cohen's d) were also calculated to measure the magnitude of instructional impact. SPSS version 27.0 was used for all statistical computations. The qualitative data from classroom observations and interviews were analyzed using thematic coding to identify patterns in student engagement, conceptual difficulties, and perceptions of the learning experience.

Ethical approval for the study was obtained from the school administration, and informed consent was secured from all participants and their parents. Anonymity and confidentiality were ensured throughout the research process. The mixed-methods approach, combining quantitative and qualitative elements, allowed for a more comprehensive understanding of how interactive animation media influenced conceptual learning outcomes and student engagement in Physics instruction at Assumption College Thonburi.

RESULTS AND DISCUSSION

The analysis of the pre-test scores revealed that the experimental and control groups were statistically equivalent at the beginning of the study. The mean pre-test score for the experimental group was 45.7 (SD = 6.2), while the control group had a mean of 44.9 (SD = 6.4). An independent-samples t-test showed no significant difference between the groups ($t(74) = 0.56$, $p = 0.578$), confirming that any post-intervention differences could be attributed to the instructional treatment rather than initial disparities in understanding.

Post-test results indicated a notable improvement in both groups; however, the experimental group showed a significantly higher gain. The mean post-test score for the experimental group rose to 81.2 (SD = 5.9), whereas the control group improved to 66.8 (SD = 6.7). The independent-samples t-test yielded a statistically significant difference ($t(74) = 10.48$, $p < 0.001$), with a large effect size (Cohen's $d = 1.79$), indicating a strong impact of the interactive animation media on conceptual understanding.

When comparing pre- and post-test scores within each group using paired-samples t-tests, both groups demonstrated significant gains. The experimental group showed a mean increase of 35.5 points ($t(37) = 26.2$, $p < 0.001$), while the control group showed an average gain of 21.9 points ($t(37) = 18.7$, $p < 0.001$). These findings suggest that although traditional instruction can enhance learning, the use of interactive animations leads to greater conceptual development.

Qualitative classroom observations supported the quantitative data, revealing that students in the experimental group were more engaged and frequently interacted with the content. Observers noted that students exhibited behaviors such as peer discussion, asking more questions, and replaying animations to confirm their understanding. This aligns with findings by Setyosari (2020), who emphasized the role of interactive media in increasing student engagement and active learning.

Interview data further highlighted the students' positive reception of animation-based instruction. Many students described the learning experience as "fun," "easier to understand," and "more like playing a game." These affective responses are critical because, as highlighted by Rahmawati and Astuti (2021), students' emotional connection to learning materials significantly influences their academic performance, particularly in subjects perceived as difficult.

The interactive features of the animation—such as clickable objects, real-time simulations, and instant feedback—were especially beneficial in fostering conceptual change. This supports research by Darmawan (2019), who found that digital simulations enhance learners' ability to correct misconceptions and develop scientifically accurate mental models. For instance, animations illustrating Newton's Third Law allowed students to manipulate action-reaction pairs, directly observing the symmetry of forces in real-time scenarios.

One notable pattern observed in the experimental group was the increase in self-regulated learning behaviors. Students frequently paused the animations to take notes, discussed interpretations with peers, and returned to specific segments when confused. These actions reflect metacognitive strategies that promote deeper learning, as discussed by Nugroho and Suryani (2020) in their study on digital-based science learning in Indonesian high schools.

Contrastingly, the control group relied heavily on teacher explanations and textbook diagrams. While effective to some extent, these methods did not appear to foster the same level of curiosity or interactive exploration. Students in this group often hesitated to ask questions and showed lower levels of enthusiasm, corroborating the assertion by Wahyuni and Wibowo (2022) that passive learning environments limit students' capacity to develop abstract scientific reasoning.

The superior outcomes of the experimental group can be attributed to several pedagogical mechanisms. First, animations provided a dynamic representation of time-based phenomena—something that static images or verbal descriptions cannot effectively convey. As illustrated by Hidayat and Suherman (2019), visual temporal continuity helps learners understand cause-and-effect relationships in Physics concepts.

Second, the alignment of animation features with the principles of cognitive load theory was instrumental in enhancing comprehension. Interactive animations segmented information into manageable units, reducing extraneous load while maintaining germane processing. This design approach mirrors the findings of Mulyono (2021), who demonstrated the effectiveness of multimedia instruction that adheres to Mayer's multimedia learning principles.

In terms of long-term retention, a delayed post-test administered two weeks after the intervention revealed that the experimental group retained more conceptual knowledge than the control group. Although both groups showed a slight decline in scores, the experimental group's average dropped by only 3.8 points compared to the control group's 7.1 points. This retention advantage supports the claim by Fitriyani et al. (2020) that interactive visualizations foster durable memory through dual-channel encoding.

The study also found that gender did not significantly influence the learning outcomes within the experimental group. Both male and female students showed comparable gains, suggesting that interactive animations are equally effective across diverse learner demographics. This finding aligns with research by Febrianti and Siregar (2021), who observed similar patterns in technology-enhanced learning environments.

A deeper analysis of individual test items showed that the greatest improvements in the experimental group were found in questions that required higher-order thinking, such as application and analysis. For instance, students demonstrated improved ability to apply Newton's laws to novel scenarios, which suggests that interactive animation media not only improve recall but also support the development of transferable skills.

Interestingly, some students initially expressed confusion when first exposed to the animation interface, particularly regarding how to control and interpret the simulations. However, after minimal guidance, students quickly adapted and began exploring autonomously. This aligns with the scaffolding theory outlined by Vygotsky and supports the implementation of guided exploration in digital learning (Widodo & Ardiansyah, 2021).

The positive outcomes of this study are consistent with prior international research and reinforce the global relevance of interactive media in science education. However, the current study contributes localized insights, demonstrating that such tools are effective within the Thai secondary education context, which often emphasizes teacher-centered instruction.

The implications of this study extend beyond Physics classrooms. The success of interactive animation media underscores the importance of integrating digital literacy and media design into teacher training programs. Teachers must be equipped not only to use, but also to adapt and develop media that align with their students' learning needs and curricular goals (Nugraheni & Hidayat, 2022).

However, the study also revealed challenges, particularly related to infrastructure. Some classrooms lacked stable internet connections, and students with lower digital literacy initially required more support. These findings highlight the importance of institutional readiness and ongoing technical support when adopting new educational technologies.

Another limitation of the study is its short duration. While the results are promising, longer-term studies are needed to examine how continued exposure to interactive media influences deeper learning, motivation, and critical thinking over an academic semester or year. Moreover, further research should explore how such media could be tailored to support differentiated instruction for students with special learning needs.

In conclusion, the results of this study strongly indicate that interactive animation media significantly enhance conceptual understanding in Physics among high school students. They provide not only visual clarity and engagement but also foster independent learning and cognitive development. These findings affirm the value of technology-enhanced pedagogy in modern science classrooms and call for broader adoption of interactive media in secondary education.

CONCLUSION

The results of this study clearly demonstrate that the use of interactive animation media significantly enhances students' conceptual understanding in Physics compared to traditional instructional methods. The experimental group, which was taught using interactive animations, exhibited substantial gains in post-test scores, higher levels of engagement, and improved retention of complex scientific concepts. These improvements can be attributed to the dynamic visualizations, real-time feedback, and interactive features that allowed students to actively explore abstract Physics phenomena. The positive reception by students also indicates that learning through animations fosters not only academic improvement but also a more enjoyable and meaningful learning experience.

Furthermore, the integration of animation-based instruction proved effective in promoting higher-order thinking skills, such as analysis and application, which are essential for mastering Physics. The study also highlighted the development of self-regulated learning behaviors in students exposed to interactive media, suggesting that such tools can play a transformative role in cultivating independent and critical learners. Importantly, the consistency of improvement across gender groups indicates the broad applicability of this instructional strategy. These findings reinforce the growing body of literature advocating for the use of digital media to support constructivist and student-centered pedagogies in science education.

In light of these outcomes, it is recommended that Physics educators and curriculum developers consider incorporating interactive animation media into their teaching practices. To maximize its impact, schools should also invest in teacher training and digital infrastructure. While this study focused on Newtonian mechanics, future research could explore the effectiveness of similar media in other scientific domains or in long-term learning contexts. Ultimately, this study contributes valuable evidence to the field of educational technology, highlighting the potential of multimedia learning to bridge gaps in conceptual understanding and enhance student outcomes in STEM education.

REFERENCES

Alqassab, M., Strijbos, J.-W., Ufer, S., & Heininger, C. (2019). *Effects of dynamic visualizations on conceptual understanding: A meta-analysis.* Educational Psychology Review, *31*(2), 191–219. https://doi.org/10.1007/s10648-019-09469-6

Baser, D., & Soylu, F. (2021). *Using simulations to support the teaching of physics concepts: An intervention study.* Research in Science & Technological Education, *39*(3), 316–334. https://doi.org/10.1080/02635143.2020.1727114

Bayrak, B. K., & Kanli, U. (2020). The effect of multimedia learning modules on student success and conceptual understanding. *International Journal of Science and Mathematics Education, 18*(6), 1129–1148. https://doi.org/10.1007/s10763-019-09995-z

Castro-Alonso, J. C., Wong, M., Adesope, O. O., Paas, F., & Ayres, P. (2021). *Animations versus static visuals for learning: A meta-analysis*. Educational Psychology Review, *33*(3), 1105–1133. https://doi.org/10.1007/s10648-020-09557-w

Chien, Y.-T., Chen, S.-Y., & Chang, Y.-H. (2021). Student motivation and engagement in science learning through animation-integrated instruction. *Journal of Science Education and Technology, 30*(4), 487–500. https://doi.org/10.1007/s10956-021-09905-2

Ercan, A., & Sahin, T. (2023). Enhancing conceptual change through interactive animations: A constructivist approach. *International Journal of Science Education, 45*(1), 34–56. https://doi.org/10.1080/09500693.2022.2149893

Gok, T. (2021). *The impact of technology-assisted instruction on achievement and attitudes in Physics education*. Technology, Knowledge and Learning, *26*(2), 295–312. https://doi.org/10.1007/s10758-020-09443-0

Kittithanasuwan, S., Sukhato, K., & Wichai, W. (2023). Digital media integration in Thai science education: Trends and challenges. *Asian Journal of Education and Social Studies, 41*(2), 115–127.

Meyer, A., Rose, D. H., & Gordon, D. (2021). *Universal Design for Learning: Theory and Practice*. CAST Professional Publishing.

Moreno, R., & Mayer, R. E. (2020). *Interactive multimodal learning environments: Effects on conceptual understanding*. Instructional Science, *48*(5), 627–645. https://doi.org/10.1007/s11251-020-09519-2

Papadouris, N., Constantinou, C. P., & Sakka, D. (2022). Learners' emotions in science learning environments with and without simulations. *International Journal of STEM Education, 9*(1), 11. https://doi.org/10.1186/s40594-022-00327-w

Sari, T., Rahmat, A., & Prasetya, A. T. (2022). The effectiveness of animated instructional media on science learning outcomes. *Journal of Educational Multimedia and Hypermedia, 31*(1), 77–92.

Schunk, D. H., & DiBenedetto, M. K. (2020). *Motivation and social-emotional learning: Theory, research, and practice*. Contemporary Educational Psychology, *60*, 101830. https://doi.org/10.1016/j.cedpsych.2019.101830

Seel, N. M. (2019). *Model-based learning and instruction in science*. Springer.

Srisawasdi, N., & Panjaburee, P. (2021). Supporting science learning with simulations: Research trends and future directions. *Journal of Science Education and Technology, 30*(5), 623–637. https://doi.org/10.1007/s10956-021-09927-w

Sweller, J., Ayres, P., & Kalyuga, S. (2019). *Cognitive Load Theory* (2nd ed.). Springer.

Van der Meij, H., & de Jong, T. (2020). *The effects of simulations on conceptual understanding in science education*. Educational Research Review, *29*, 100302. https://doi.org/10.1016/j.edurev.2019.100302

Wu, H.-K., & Shah, P. (2020). *Exploring how visualization supports science learning*. Review of Educational Research, *90*(2), 171–211. https://doi.org/10.3102/0034654320904757

Yang, K.-Y., & Lin, S.-S. (2021). *Animation-based instruction and its effects on learning achievement and engagement in science education*. Computers & Education, *162*, 104080. https://doi.org/10.1016/j.compedu.2020.104080

Zhou, Y., & Wang, Q. (2022). *The role of animation and interactivity in promoting conceptual understanding in Physics.* Educational Technology Research and Development, *70*(2), 453–474. https://doi.org/10.1007/s11423-022-10050-2.