



Development of webtoon-assisted CTL digital media on nervous system material to reduce misconceptions and increase motivation of class XI student

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Abstract

Conceptual understanding is an essential aspect of biology learning, yet students often experience low mastery of concepts and misconceptions. This development study aimed to develop and evaluate the validity, practicality, and effectiveness of a webtoon-assisted Contextual Teaching and Learning (CTL) digital comic on the nervous system to reduce misconceptions and improve students' learning motivation. The study applied the ADDIE development model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. The participants were 60 grade XI students divided into experimental and control groups. Data were collected using a Three-tier Misconception Test and a validated learning motivation questionnaire. Data analysis employed MANOVA and N-gain calculations to determine reductions in misconceptions and improvements in motivation. The findings revealed that the developed digital comic was valid according to media experts (4.1; acceptable) and material experts (4.5; very acceptable). It was also considered highly practical based on teacher responses (3.61) and student responses (3.38). Furthermore, the digital comic proved effective in reducing misconceptions and increasing learning motivation, indicated by significant differences between the experimental and control groups (Wilks' Lambda = 0.014). The experimental group achieved a moderate reduction in misconceptions (N-gain = 0.42) and a low increase in learning motivation (N-gain = 0.16). These findings demonstrate the potential of digital webtoons integrated with CTL to reduce misunderstandings and support learning motivation. These findings also contribute to the development of contextual digital media for biology education.

Abstrak. Pemahaman konseptual merupakan aspek penting dalam pembelajaran biologi, namun siswa sering kali mengalami penguasaan konsep yang rendah dan memiliki kesalahpahaman. Penelitian pengembangan ini bertujuan untuk mengembangkan serta mengevaluasi validitas, kepraktisan, dan efektivitas komik digital berbasis webtoon yang mengadopsi pendekatan Pengajaran dan Pembelajaran Kontekstual (CTL) mengenai sistem saraf guna mengurangi miskonsepsi dan meningkatkan motivasi belajar siswa. Penelitian ini menerapkan model pengembangan ADDIE, yang terdiri dari tahap Analisis, Desain, Pengembangan, Implementasi, dan Evaluasi. Peserta penelitian adalah 60 siswa kelas XI yang dibagi menjadi kelompok eksperimen dan kelompok kontrol. Data dikumpulkan menggunakan Uji miskonsepsi tiga tingkat dan kuesioner motivasi belajar yang telah divalidasi. Analisis data menggunakan MANOVA dan perhitungan N-gain untuk menentukan pengurangan miskonsepsi dan peningkatan motivasi. Temuan menunjukkan bahwa komik digital yang dikembangkan valid menurut ahli media (4,1; dapat diterima) dan ahli materi (4,5; sangat dapat diterima). Komik tersebut juga dianggap sangat praktis berdasarkan tanggapan guru (3,61) dan siswa (3,38). Selain itu, komik digital terbukti efektif dalam mengurangi miskonsepsi dan meningkatkan motivasi belajar, yang ditunjukkan oleh perbedaan yang signifikan antara kelompok eksperimen dan kelompok kontrol (Wilks' Lambda = 0,014). Kelompok eksperimen mencapai pengurangan miskonsepsi yang moderat (N-gain = 0,42) dan peningkatan motivasi belajar yang rendah (N-gain = 0,16). Temuan-temuan ini menunjukkan potensi komik digital webtoon yang terintegrasi dengan CTL dalam mengurangi kesalahpahaman dan mendukung motivasi belajar. Temuan-temuan ini juga berkontribusi pada pengembangan media digital kontekstual untuk pendidikan biologi.

A. Introduction

Concept understanding is an essential ability to be possessed by students in the learning process. In biology subjects, students are required to understand the concepts of material that is often complex, abstract, and difficult to sense directly (Rohmawati & Yuliani, 2018). However, in reality, students' mastery of Natural Science (IPA) concepts is still relatively low, and there is often a misunderstanding of the concepts learned (Suendarti, 2020).

Low understanding of concepts can be caused by various factors, including misconceptions (Fuadi et al., 2020). Misconception is an incorrect understanding of a concept, which often comes from incomplete information but is believed to be true by students (Handhika, 2019). This condition can be caused by errors in the initial concepts that have been embedded or the low interest of students in learning the material (Efriana, 2014). Therefore, interest and learning motivation are important aspects that need to be considered, considering that learning motivation is an internal drive that encourages students to be actively involved in the learning process so that learning objectives can be achieved (Cahyani et al., 2020).

One of the materials that is known to have a high level of difficulty and has the potential to cause misconceptions is the nervous system. This material covers a wide scope and involves abstract physiological concepts, so it requires more effort from students to understand it as a whole (Kagnici & Sadi, 2021; Moro, 2023). The high level of complexity and abstract nature of this material can have an impact on decreasing students' interest and motivation to learn. Based on the results of interviews conducted by researchers with biology teachers in one of the high schools in Sidoarjo Regency, it is known that students' learning motivation in understanding nervous system material is still low. This affected their learning outcomes, which remained below the passing grade criteria. The teacher said that one of the efforts that can be made to overcome this is by linking nervous system material with real objects such as the five senses, so that the material becomes more contextual and easier to understand. However, this finding is only based on interviews and should be supported by preliminary test data or questionnaire results.

An effort that can be made to create contextualised learning is by applying the Contextual Teaching and Learning (CTL) learning model. This model emphasizes the importance of linking learning materials with the real life situation of students, so that it can increase their activeness and learning outcomes. The effectiveness of CTL is supported by the constructivism stage that allows students to link their prior knowledge with their daily learning experiences (Sinaga & Silaban, 2020). The concepts emphasized in contextual learning will correct misconceptions in learning materials (Munirat & Vitasari, 2013). Contextual learning will be more optimal if supported

by interesting and relevant learning media. One of the appropriate media is digital comics, which are able to convey material visually and fun.

Along with the development of the Society 5.0 era, technological innovation in education is crucial to improve the quality of learning. The utilization of digital media such as webtoon is one of the innovative alternatives that can be utilized as digital comic-based learning media (Fricticarani et al., 2023). In a study conducted by Cricilia and Ratnasari (2024), the use of webtoon-based digital comics on protein synthesis material showed a positive response from students up to 95.5%, and was able to significantly improve concept understanding and learning motivation.

Based on various studies that have been conducted, webtoon-based digital comic media has been proven to improve student learning outcomes and motivation. However, there is still limited research that develops webtoon-based digital comic media integrated with the Contextual Teaching and Learning (CTL) approach and examines its effect on reducing misconceptions and increasing student motivation in nervous system material. In addition, there has been no research that specifically examines the application of this media in accordance with the conditions of students at one of the high schools in Sidoarjo Regency.

Therefore, it is necessary to develop learning media in the form of webtoon-based digital comics that are not only visually appealing but also contextual and relevant to students' lives. The development of this media is expected to be a solution to reduce misunderstandings and increase student learning motivation in studying nervous system material.

B. Material and method

This study employed a research and development (R&D) approach using the ADDIE model with 5 stages of research, which analysis, design, development, implementation, and evaluation. The instruments used are interview guidelines, validation sheets, practicality sheets, readability sheets and learning motivation questionnaires and student misconception tests. The misconception test sheet used is a three-tier test sheet.

The research procedure includes the stages of analysis, design, development, implementation, and evaluation. In the analysis stage, student needs, curriculum, and supporting infrastructure are analyzed using qualitative and quantitative analysis techniques to identify problems, needs, and solutions as a basis for development. Based on the analysis stage, problems and solutions can be determined, followed by the design stage, which involves designing materials that will be emphasized in learning, media, and comic storylines. The storylines that have been designed are then developed into webtoon products and assessed by validators and practitioners as well as limited trials so that the results can be used as a benchmark for

improvement. The implementation stage is carried out through field testing via pre- and post-tests on misunderstandings and learning motivation questionnaires. The evaluation stage is conducted to revise each stage that has been implemented. The limited test subjects used were 12th grade students who had already learned about the nervous system. The test subjects were 11th grade students who would learn about the nervous system, divided into two classes that were treated differently.

Calculation of feasibility and practicality is obtained based on the assessment of the validator. The feasibility score is obtained by calculating the Likert scale. The total score obtained is then calculated into an equation per aspect. The average result data per aspect, then interpreted based on the scoring system and criteria. The content validity of the instrument was assessed using expert assessment with a questionnaire, while the construct validity of the instrument was assessed using Rasch model measurement in SPSS. The reliability of the instrument was also calculated using Cronbach's alpha test (KR-20) measurement in SPSS.

The effectiveness of the product was assessed using SPSS calculations using the MANOVA test which previously went through the prerequisite test, namely the normality and homogeneity tests. Furthermore, the N-gain calculation was carried out to determine the reduction of misconceptions and the increase in

students' misconceptions. The formula used to calculate N-Gain is shown in Formula 1 (Hake, 1998):

$$n - \text{gain (G)} = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}} \dots \text{Formula 1}$$

C. Results and discussion

The result of this development is a digital comic with a CTL (contextual Teaching and Learning) approach assisted by webtoon application. The research began with the analysis stage obtained by conducting interviews and observations showing that one of the schools in Sidoarjo Regency had difficulty in improving student learning outcomes in nervous system material. At the design or planning stage, researchers plan digital comic products based on the results of the analysis. The results of the analysis became the basis for developing digital comics by paying attention to important topics in nervous system material to reduce misconceptions and attractive displays to increase student motivation.

The development stage was carried out by conducting lesson planning, overall comic development and validity and practicality assessments. Comics were developed using the Ibis paint X and Canva applications. The results of the comics developed were then assessed for validity and feasibility (see Figure 1).

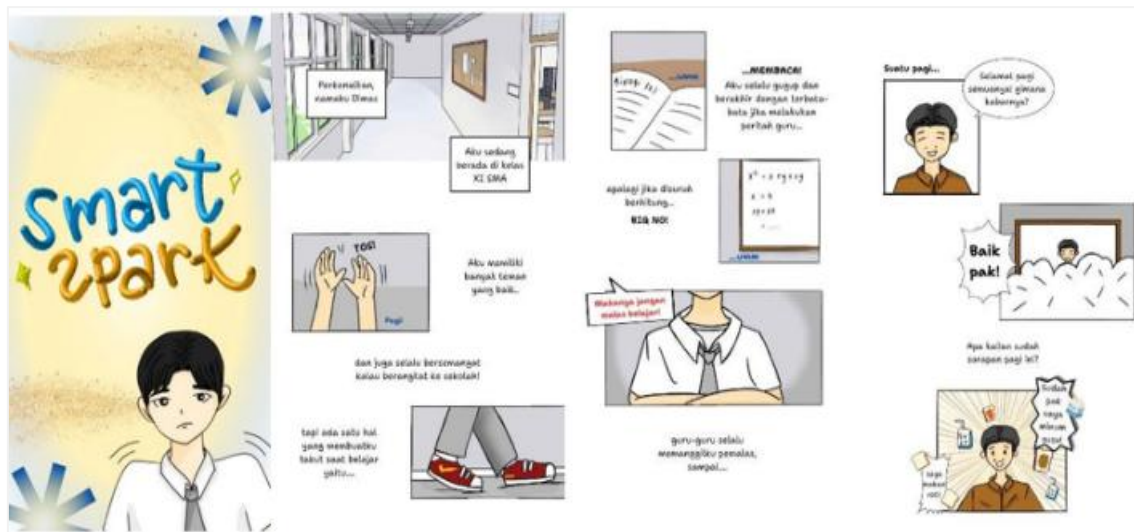


Figure 1 Smart spark digital comic result

Validity or feasibility was carried out by material experts and media experts. Both validators are lecturers from Yogyakarta State University who are experts in their fields. The validation results aim to find out the expert's opinion on the digital comics developed so that improvements and optimization can be made in the development of digital comics. The results of the media expert validation analysis are presented in the Table 1.

The aspects assessed in the media expert assessment include several aspects such as effectiveness & efficiency, proportion of visual presentation, language use, display quality and design quality. Expert assessment shows that overall, the developed CTL digital comic media of the nervous system is suitable for use in biology learning in terms of media with an average score of 4.1 and improvements are made based on the suggestions

given. The display quality aspect gets the highest average score assessment with very feasible criteria.

On the other hand, there is a material expert validation assessment which includes several aspects such as aspects of the suitability of the material to the learning outcomes, the accuracy of the material, the

sophistication of the material, presentation techniques, aspects of supporting learning, suitability for learner development, communicative, straightforward and conformity with Indonesian language rules. The results of the material expert assessment can be seen in the Table 2.

Table 1 Results of media expert assessment

Aspect	Average score	Criteria
Effective & efficient	4.0	Feasible
Proportion of visual presentation	4.0	Feasible
Communicative use of language	4.0	Feasible
Display quality	4.7	Very feasible
Design quality	4.0	Feasible
Total average	4.1	Feasible

Table 2 Results of material expert assessment

Aspect	Average score	Criteria
Suitability of material	4.4	Very feasible
The accuracy of the material	4.6	Very feasible
Provenance of the material	5.0	Very feasible
Presentation technique	4.7	Very feasible
Learning support aspects	5.0	Very feasible
Suitability for learner development	4.0	Very feasible
Communicative	4.5	Very feasible
Straightforward	4.5	Very feasible
Conformity with Indonesian language rules	4.0	Very feasible
Total average	4.5	Very feasible

Table 3 Results of teacher assessment

Aspect	Average score	Criteria
Software engineering	3.0	Practical
Visual communication	4.0	Very practical
Feasibility of material	3.5	Very practical
Accuracy of material	3.5	Very practical
Didactics	4.0	Very practical
Language	4.0	Very practical
Construction	3.4	Very practical
Technical	3.5	Very practical
Total average	3.6	Very practical

The results of the assessment of digital comic media by material experts show that overall, the average score is 4.5 and is in the 'very feasible' category to be used in the learning process. Thus, the digital comics developed meet the eligibility standards in terms of material quality to be used in learning nervous system material by making improvements based on suggestions.

Teacher response tests were conducted to determine the practicality of the digital comic media developed. Aspects assessed by practitioners include aspects of software engineering, visual communication, material feasibility, material accuracy, didactics, language, construction, and technical. The results of the practitioner's assessment can be seen in the Table 3.

Based on the results of the biology teacher's assessment of the digital comics developed, overall, the

digital comics developed obtained an average score of 3.61 which is included in the 'very practical' category. This is in alignment with Daniel's (2020) research, which states that appropriate learning media can improve students' understanding of learning materials. This shows that the digital comics developed meet the criteria of practicality and are very feasible to use in learning biology. On the other hand, students also rated the presentation aspect with the second highest score, indicating that they found the digital comics easy to access the result consistent with the research by Pratiwi et al. (2022), which noted that the practicality of digital media is influenced by how flexibly users can access it. The implementation stage was carried out to determine the effectiveness of the digital comic products developed by conducting field trials. Field trials were conducted to measure the comparison of misconceptions and learning

motivation of students before and after using the developed media products.

The misconception and learning motivation tests were carried out using pretests and posttests in two classes, namely the control class and the experimental class. The results of the field tests that have been conducted show significant differences in the variables of misunderstanding and student learning motivation after the use of digital comics. This difference can be seen from the pretest and posttest results analyzed using the MANOVA test. The MANOVA

test results show a Wilks' Lambda significance value of 0.014 ($p < 0.05$), which is lower than the probability value, indicating that there is a difference in students' misconceptions and learning motivation when using digital comics.

To determine the effectiveness of reducing misconceptions and increasing student motivation in experimental and control classes and improving student learning outcomes, the N-gain test was conducted. The results of the N-gain test on the control and experimental classes can be seen in the Figure 2.

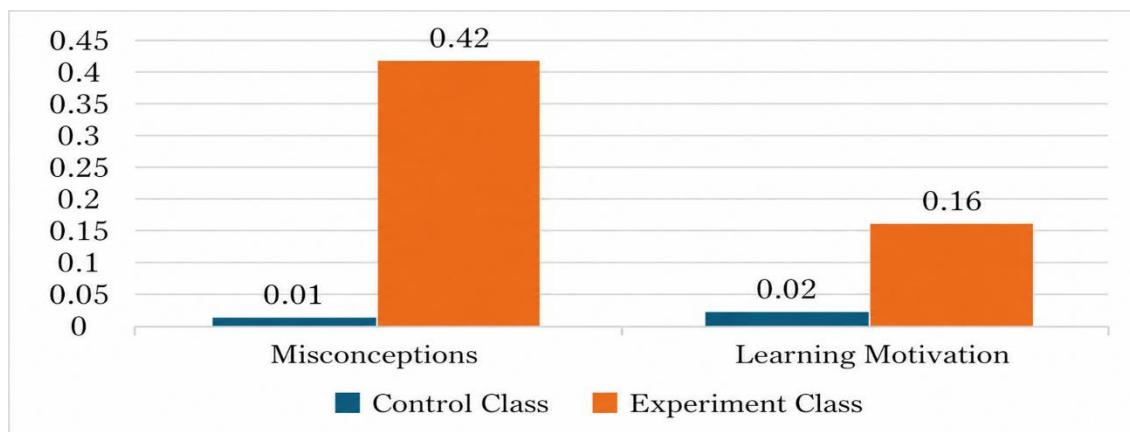


Figure 2 Diagram of N-gain value of misconceptions and learning motivation

The N-gain test results of students' misconception reduction showed that the N-gain score in the experimental class was 0.42 which was in the medium category. While the N-gain score in the control class is 0.01 which is included in the low category. This shows the difference in the reduction of students' misconceptions in each class. Based on the N-gain results in both classes, the reduction of misconceptions in the experimental class is better than the control class. So, it can be concluded that the use of digital comics is effective in providing a positive influence. This is line with the research by Islamiyah et al. (2022) and Zulfira et al. (2024), which states that learning media can reduce learning misconceptions.

On the other hand, the N-gain score of students' learning motivation in both classes is in the low category with the N-gain value of the experimental class is 0.16 and the control class is 0.02. Although the N-gain score in both classes is low, the N-gain score in the experimental class is higher than the control class. So, there are indications that the increase in student learning motivation in the experimental class is relatively better than the control class, although the increase is still relatively low. This supports the statements in the research by Cricilia and Ratnasari (2024) that the development of webtoon-based digital comic media can improve student learning motivation.

The findings of this study are closely related to the issues identified in the research background. Preliminary analysis indicates that students experience misconceptions and low motivation to

learn about the nervous system due to its abstract nature, broad scope, and limited relevance to daily life. The greater reduction in misconceptions observed in the experimental class suggests that digital comics integrated with CTL successfully addressed these challenges by presenting biological concepts in a more concrete and contextual manner. Through visual narratives and real-life situations related to the nervous system and sensory organs, students were encouraged to connect prior knowledge with new concepts, thereby facilitating conceptual change and reducing misconceptions. These findings support the theoretical perspective that contextual learning and visual media can help reconstruct students' prior misconceptions into scientifically accepted concepts.

Furthermore, although the increase in learning motivation was still classified as low, the higher N-gain scores in the experimental class indicate that the digital comics developed have the potential to address the motivation issues identified in the preliminary study. Engaging visual presentation and a contextual storyline may have increased students' interest and engagement during the learning process, although the magnitude of this increase was limited. This suggests that motivation is influenced by various internal and external factors, and the use of digital comics alone may not be sufficient to produce significant changes within a relatively short intervention period. Nevertheless, these findings indicate that the developed medium offers an initial solution to the educational problems highlighted in the research

background, particularly in reducing misconceptions and supporting students' motivation to learn about the nervous system. Therefore, further refinement of the digital comics and their implementation strategies is needed to maximize their educational impact and better address the learning difficulties experienced by students.

The effectiveness of digital comics integrated with CTL in reducing students' misconceptions can be explained theoretically through the constructivist learning perspective. According to constructivist theory, students actively construct new knowledge by integrating new information into their existing cognitive structures (Ondog & Kilag, 2023; AlAfnan & Dishari, 2024). Misconceptions arise when prior knowledge is inconsistent with scientific concepts and is often difficult to change, unless students experience meaningful learning experiences that challenge their existing beliefs (Assem et al., 2024). The CTL approach facilitates this process by connecting abstract biological concepts to students' real-life experiences, thereby enabling them to reconstruct their understanding through contextual situations (Abdullah & Shohib, 2025). Meanwhile, digital comics provide visual representations and narrative sequences that simplify complex concepts, making it easier for students to organize and assimilate new information. This combination creates opportunities for conceptual change, which in turn contributes to the reduction in misconceptions observed in the experimental class.

From a learning motivation perspective, these findings can be interpreted using learning motivation theories, particularly the ARCS model and the principles of multimedia learning. The visual and narrative characteristics of digital comics are able to capture students' attention and stimulate curiosity, while the contextual storyline enhances the perceived relevance of the learning material to everyday life (Rasmet et al., 2025; Nufus & Warrah, 2026). These aspects can enhance students' intrinsic motivation by making learning activities more engaging and meaningful (Luarn et al., 2023; Harpine, 2024). However, the relatively modest increase in motivation suggests that learning motivation is a multidimensional construct influenced not only by instructional media but also by individual characteristics, the learning environment, prior achievement, and teaching strategies (Cayubit, 2022; Osathanunkul et al., 2026). Therefore, although digital comics integrated with CTL can serve as an effective external stimulus to support motivation, sustained improvement may require a longer implementation period as well as the integration of additional teaching approaches that foster autonomy, competence, and active participation in the learning process.

However, in this study, no effect size test was conducted because the main objective of this study was to develop a product that could be used to reduce

misunderstandings and increase student learning motivation. Based on these results, it is evident that the digital comic developed on the nervous system is not yet optimal and presents opportunities for further research to improve the quality of digital learning media so that digital comics can be more effective in reducing the percentage of misunderstandings among students.

D. Conclusion

Based on the results of the development research conducted, it can be concluded that webtoon-assisted CTL digital comics on nervous system material are suitable for use in learning biology based on the validation results of media experts and material experts. Digital comics might also reduce misunderstandings and boost students' motivation to learn. This is assessed based on the results of the MANOVA test (0.014) and supported by the results of the N-gain test. Thus, webtoon-based CTL digital comics on nervous system material can help teachers as learning media in reducing misconceptions and become attractive media for students so that students' learning motivation increases. The imperfections of this resource can be used for further research by optimizing the presentations and content of the nervous system material, as well as developing comics for broader subject matter.

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