



## Development integrated science learning device on human digestive system material based on inquiry-flipped classroom

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Article Information	Abstract
<p><b>Keyword:</b> Development; Learning devices; Inquiry-flipped classroom; Learning model; Digestive system</p> <p><b>Kata Kunci:</b> Pengembangan; Perangkat pembelajaran; Inkuiri dengan kelas terbalik; Model pembelajaran; Sistem pencernaan</p> <hr/> <p><b>History:</b> Received : 19/12/2023 Accepted : 08/02/2024</p>	<p>At Rosa Mystica Catholic Junior High School, networked learning has not been linked to specific learning models and media. Teachers still face difficulties in creating online learning devices. It is necessary to develop learning devices using appropriate learning models and media to assist teachers in learning online. This will positively impact the quality of learning in the network at school. This study aimed to assess the Integrated Science learning device's validity, effectiveness, and practicality based on the inquiry-flipped classroom approach. The study developed learning devices such as syllabus, lesson plans, and electronic student worksheets. The research was conducted in January 2022 at Rosa Mystica Catholic Junior High School. This is a research and development project that uses the ADDIE model. The research findings indicate that the inquiry-based flipped classroom learning device is highly valid, effective, and practical. It is suitable for integrated science learning, specifically the human digestive system. This study contributes to the innovation of integrated science learning, as the combination of inquiry-based and flipped classroom models can create a more effective and engaging learning experience for students.</p> <p><i>Abstrak.</i> Pembelajaran dalam jaringan yang terjadi di sekolah menengah pertama katolik Rosa Mystica belum terkait dengan model dan media pembelajaran tertentu. Guru masih kesulitan membuat perangkat pembelajaran untuk pembelajaran dalam jaringan. Perlu dilakukan pengembangan perangkat pembelajaran menggunakan model dan media pembelajaran untuk membantu guru dalam melaksanakan proses pembelajaran dalam jaringan yang berdampak pada perbaikan kualitas pembelajaran dalam jaringan di sekolah. Tujuan penelitian ini adalah untuk mengetahui validitas, efektifitas perangkat dan kepraktisan perangkat pembelajaran IPA Terpadu berbasis inkuiri-flipped classroom. Perangkat pembelajaran yang dikembangkan dalam penelitian ini adalah silabus, rencana pelaksanaan pembelajaran dan lembar kerja peserta didik elektronik berbasis model pembelajaran inkuiri-flipped classroom. Penelitian ini dilaksanakan pada bulan Januari tahun 2022 di SMPK Rosa Mystica. Penelitian ini merupakan penelitian dan pengembangan menggunakan model ADDIE. Hasil penelitian ini menunjukkan bahwa perangkat pembelajaran berbasis inkuiri-flipped classroom sangat valid, efektif dan praktis sehingga layak digunakan dalam pembelajaran IPA terpadu materi sistem pencernaan pada manusia. Penelitian ini memberikan kontribusi terhadap inovasi dalam pembelajaran IPA Terpadu, penggabungan model pembelajaran inkuiri dan flipped classroom dapat membuat pembelajaran yang lebih efektif dan menarik bagi peserta didik.</p>

## A. Introduction

Information technology significantly impacts all aspects of life today, as well as education (Nurhijrah, 2023). Information technology allows teachers and learners to access various learning resources online (Shatri, 2020). Information technology can support the learning process optimally, removing barriers for all teachers and students in accessing information from multiple sources. During the COVID-19 pandemic, the importance of using technology in learning has increased due to the change from face-to-face learning in the classroom to online learning (Widianto et al., 2021).

Network learning at Rosa Mystica Catholic Junior High School during the pandemic was still limited to giving assignments to students through the WhatsApp application and then several face-to-face meetings through the Zoom application and learning in class. However, it was altered by time. Learning in the classroom has not been linked to specific learning models and media. This condition forces teachers to adapt to designing engaging online learning by prioritizing students' learning experiences so that students are not quickly bored and remain enthusiastic to play an active role in learning. However, teachers still have difficulty making learning devices for online learning because online learning is still relatively new. Thus, it is necessary to develop learning devices using learning models and media to support teachers in carrying out the learning process in networks that improve the quality of learning in school networks. The tools developed in this research are a syllabus, lesson plan, and electronic student worksheet based on an inquiry-flipped classroom learning model.

The inquiry learning model is designed so that students can ask questions and investigate something critically, logically, and systematically using all their abilities (Andrini, 2016). Inquiry learning is suitable to be applied in science learning because the focus of science learning is not only on memorized material and scientific information but more on how to teach students to understand the concepts learned and apply them through a scientific method (Bell et al., 2010).

For online learning through the inquiry learning model to run well, it must be combined with the flipped classroom model. The flipped classroom model is an ideal virtual learning model for biology learning (Ridlo et al., 2022). The application of the flipped classroom model in learning is closely related to the use of technology, especially the Internet. Using the Internet as a learning device, students can broaden their horizons and explore knowledge more broadly (Ningsih et al., 2018). Flipped classroom learning is learner-centered because pre-class activities facilitate learners to learn learning materials online by watching videos or through textbooks (Jensen et al., 2018).

Flipped classroom has two main activities: pre-class learning activities and in-class learning activities. To implement pre-class activities, teachers prepare teaching materials and learning videos recorded by themselves, search for materials through appropriate online media, and give homework to students. Learners read/listen/watch the material provided while doing the homework assigned by the teacher. At the same time, in-class activities include deepening material and solving problems that have not been resolved in pre-class activities. In classroom activities, the teacher acts as a facilitator rather than a provider of information. Activities in the classroom allow teachers to help students with difficulty in learning (Latorre-Coscolluela et al., 2021; Zupanec et al., 2022).

These two learning models can complement each other. The inquiry learning model is a discovery learning. In contrast, the flipped classroom learning model is a blended learning approach, which allows students to conduct independent learning outside the classroom online and face-to-face activities in the classroom. Thus, the inquiry-flipped classroom learning model prioritizes the discovery process, where students independently explore and understand concepts through online learning outside the classroom and discuss the classroom findings with the teacher's help as a facilitator (Nurhayati et al., 2019).

There are several research publications related to the development of inquiry-based learning devices in biology learning (Fadilah et al., 2015; Islamiyah, 2019; Prophylia et al., 2014; Sainab & Herna, 2022; Setyowati et al., 2019), and research publications related to the development of flipped classroom-based learning devices in learning mathematics, physics, and chemistry (Handayani et al., 2021; Nyeneng et al., 2018; Sihaloho et al., 2017). However, there are no research publications related to the development of inquiry-based flipped classrooms in integrated science subjects, specifically on the material of the human digestive system.

## B. Material and method

The research was conducted in January 2022 at Rosa Mystica Kupang Catholic Junior High School as part of the integrated science subject. The study focused on the digestive system in humans. This research is a research and development (R&D) using the ADDIE model (analyze, design, develop, implement, and evaluate), which is adapted from the design of the ADDIE model (Rayanto & Sugianti, 2020)

At the analysis stage, researchers conducted a theoretical study by studying the literature on the development of inquiry-flipped classroom devices to find reasons for their development. After that, the needs analysis of teachers and students related to the

learning devices to be developed was carried out. At the Design stage, researchers designed a draft of the inquiry-flipped classroom learning device on the material of the food digestive system by paying attention to the suitability of the components contained in the learning device with the curriculum and the learning model used. At this stage, researchers also compiled instruments that experts and practitioners would use to assess the learning devices developed. At the Develop stage, the inquiry-based flipped classroom learning devices are validated by validators using learning device assessment instruments. Validation of learning devices is carried out by practitioners, material experts, and media experts. The category for the validity of learning devices can be seen in Table 1.

**Table 1 The validity category**

Percentage (%)	Category
81-100	Very valid
61-80	Valid
41-60	Quite valid
21-40	Less valid
0-20	Not valid

At the implementation stage, the inquiry-flipped classroom-based learning devices declared valid by experts are tested in learning to determine the effectiveness and practicality of the learning devices developed. Before the trial, students took a pre-test, then applied the inquiry-based flipped classroom learning device on digestive system material, and at the end of the learning, were given a post-test. The effectiveness of the learning devices developed can be seen from the increase in the average N-Gain of student learning outcomes before and after participating in learning using the Inquiry Flipped Classroom learning device. Apart from that, the practicality of the learning devices developed can be seen from the practicality of the learning devices developed. Student responses through a questionnaire on the practicality of learning devices are filled out at the end of the lesson. The category for the practicality of the device can be seen in Table 2.

**Table 2 The practicality category**

Percentage (%)	Category
81-100	Very practical
61-80	Practical
41-60	Quite practical
21-40	Less practical
0-20	Not practical

In the evaluate stage, researchers make final revisions to the inquiry-based flipped classroom based on the results of the application in learning.

## C. Results and discussion

The study developed learning devices such as syllabus, lesson plans, and electronic student worksheets to aid in the integrated science learning of the digestive system in humans. A practicum video was also created to test food ingredients as a learning medium. The video's link was included in the electronic student worksheets, which students could access when studying independently at home (see Figure 1). The learning devices devised were modified to comply with the curriculum adopted at Rosa Mistyca Catholic junior high school, specifically the 2013 curriculum. The validation outcomes of the syllabus, lesson plans, electronic student worksheets, and learning videos are provided in Table 3.

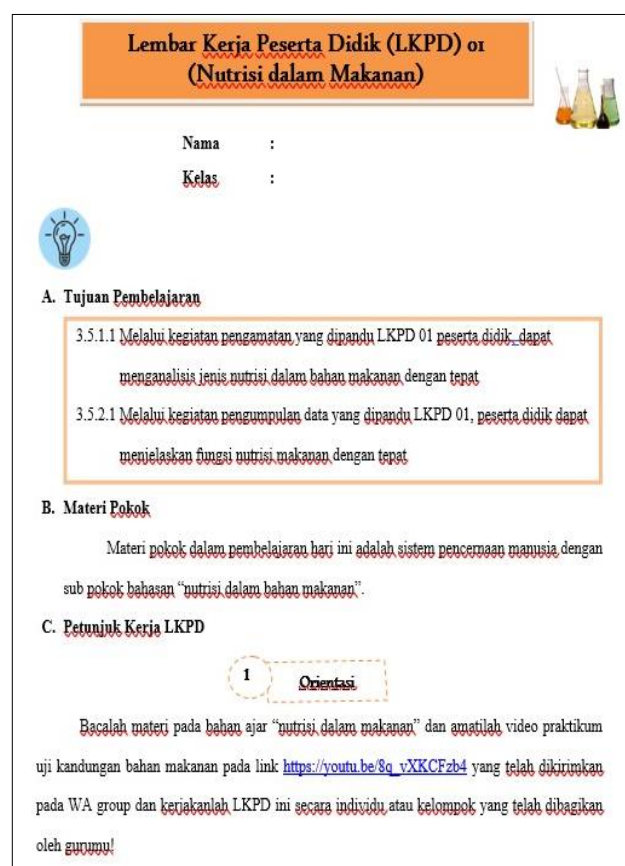


Figure 1  
 Student electronic worksheets are equipped with video links  
 (in Indonesian)

**Table 3 Results of learning device validation by experts and practitioners**

Learning devices	Category	Percentage
Syllabus	92.5%	Very valid
Lesson plan	93%	Very valid
Electronic student worksheet	90%	Very valid
Learning video	95%	Very valid

Table 3 shows that the validator assessed 93% of the lesson plan aspects, while the electronic student worksheet achieved 90%. Moreover, the electronic student worksheet scored 95%, and the learning video scored 95%. All the learning devices developed are classified as highly valid. However, the

device assessment results indicate the need for minor improvements to enhance the learning device, as presented in Table 4. According to Table 4, material experts and practitioners have identified numerous ways to improve the components of the developed syllabus and lesson plans.

**Table 4 Outlines suggestions for improving learning devices through the inquiry-flipped classroom approach.**

Expert	Assessed aspects	Suggested improvements	Improvement result
Material	Syllabus	The collection of information and participating in learning activities should be clarified to enhance their relevance to the learning material.	The learning activities have provided a clear account of the process of gathering information and linking it to the content related to the digestive system.
Practitioner		Please provide details of the teaching and learning activities undertaken by teachers and students, as the syllabus only provides a description of student activities.	Described the activities of teachers and learners in learning activities.
Material	Lesson Plan	Skills assessment and attitude assessment should be included.	The learning assessment includes skills assessment and attitude assessment

The syllabus guides crafting lesson plans in a specific subject (Abdurrahman, 2022). Learning activities form part of the syllabus, encompassing teacher and learner activities. Therefore, when outlining learning activities, it is essential to provide a distinct description of teacher and learner activities (scientific approach: observation, questioning, gathering information, association, and communication) that are relevant to the specific subject being taught.

One of the lesson plan's constituents is the assessment. The 2013 curriculum's assessment comprises attitude, knowledge, and skill. Therefore, in lesson planning, teachers should design evaluations for learning and students' attitudes and abilities. Their knowledge positively influences Learners' skills, while the skill aspect remains closely linked with the attitude component. Knowledge and attitude manifest through learners' skills (Amran & Agustang, 2020).

The flipped classroom inquiry model facilitates the evaluation of learners' attitudes towards independence, responsibility, and cooperation through various learning activities (Blau & Shamir-Inbal, 2017; Altemueller & Lindquist, 2017). The model assesses learners' skills in presenting the outcomes of their investigations during practical sessions (Kaeophanuek & Chookerd, 2021).

The initial step in assessing learning outcomes involved administering a pre-test to determine students' baseline level before instruction that employed inquiry-based flipped classroom learning devices. Following this, researchers implemented the said tools during instruction. So, students underwent a post-test to gauge their final performance using the inquiry-based flipped classroom learning model. The summary of the students' pre- and post-learning achievements utilizing inquiry-flipped classroom-

based learning devices is available in Table 5. There has been an improvement in student learning outcomes from 34.21 to 65.53, with an N-Gain score of 0.48 in the medium category.

**Table 5 Recapitulation of students' learning outcomes**

Pre test	Post test	N-Gain	Category
34.21	65.53	0.48	Medium

Implementing learning following the syntax of the flipped classroom inquiry learning model has influenced this increase in learning outcomes in the study. Learning commences with asynchronous activities, wherein students read learning materials, view educational videos, and complete electronic student worksheets founded on inquiry-based flipped classroom pedagogy. Following this, synchronous learning ensues, where students discuss the aforementioned electronic learner worksheets about the stages of inquiry. Moreover, students submit their tasks through the class Whatsapp group, and the teacher assesses them. The activities carried out in this inquiry-flipped classroom learning encourage students to discover the concepts they learn independently, take responsibility in doing every task given to them, and encourage students to cooperate with their friends during discussions or practicums in the classroom to impact student learning outcomes positively.

Learning devices are effective if they increase student learning outcomes (Siburian et al., 2019; Samidi et al., 2019). The learning devices developed in this study are effective for learning Integrated Science material on the human digestive system. The study utilized a questionnaire to gather learners' feedback regarding the learning devices used during lessons,

namely digital student worksheets and instructional videos. Figure 2 displays learners' reactions to the learning tools implemented.

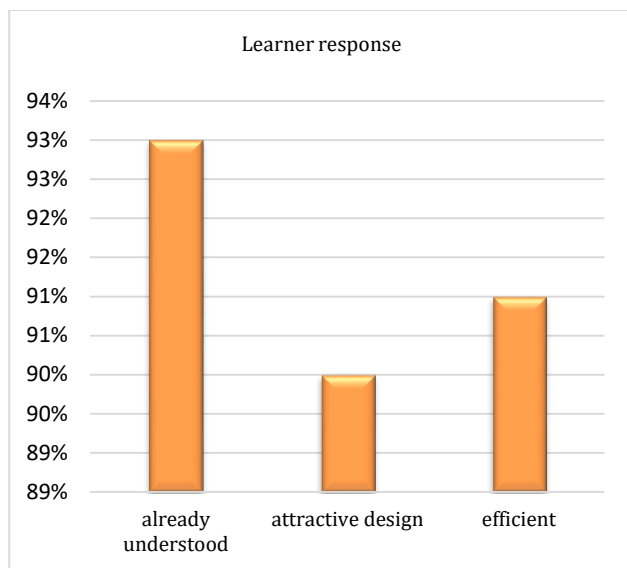


Figure 2  
Diagram of learners' response to electronic learners' worksheet and learning video

Based on Figure 2, students' feedback on the developed learning devices corresponds to the practical category. As many as 93% of the learners reported finding the learning devices easy to comprehend. This indicates that the electronic worksheet designed for learners uses simple vocabulary, which facilitates completing the task. Additionally, the learning video enhances the learners' understanding of the food ingredient test practicum by providing a step-by-step approach. Although they do not participate in the practicum, watching learning videos enables them to analyze the content of substances in food ingredients effectively.

Creating learning materials, including electronic worksheets and videos, has reached a 90% completion rate. This success is attributable to incorporating visually appealing images, fonts, and colors within the electronic worksheets. In addition, the learning videos are equipped with high-quality pictures of exemplary practicum materials and tools, clear audio, and high-resolution video, resulting in an unambiguous video display. Such design elements enhance learners' interest in and motivation to work on these materials.

The effectiveness of electronic learner worksheets and learning videos is also rated as very good, at 91%. By providing accessible learning video links within the electronic worksheets, students can make more efficient use of their learning time by completing the worksheets at home before attending class. This allows classroom time to discuss their work with the teacher and fellow students.

Innovative electronic student worksheets structured as learning materials and practical exercises are essential for online students as they facilitate learning (Seralidou & Douligeris, 2021; Suryaningsih & Nurlita, 2021). In the final stage, the learning device is evaluated based on the learners' responses to its practicality. All students responded positively to the inquiry-based flipped classroom learning devices, indicating that the tools developed meet the needs of students.

The results of this study are consistent with the research by Rizkivany & Mawardi (2021); Maullidyawati et al. (2022); Ramadani et al. (2023); Epinur & Minarni (2023) that the inquiry-flipped classroom-based learning devices developed are valid, effective, and practical. Still, the devices developed in previous studies were only electronic student worksheets or learning system. In this study, the devices developed were curriculum, lesson plans, and electronic student worksheets and applied to integrated science learning of human digestive system material.

## D. Conclusion

The inquiry-flipped classroom learning model is a valid, effective, and practical tool for science education, particularly for teaching the human digestive system. This study contributes to innovation in integrated science education by combining inquiry and flipped classroom learning models, making learning more effective and engaging for students. This research aims to enhance student engagement in learning integrated science material on the human digestive system. This can be achieved through individual self-study before class and group inquiry activities during class. Active participation in individual and group activities facilitates a better understanding of the material.

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