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The Need for an Interactive Cell Biology Textbook Based on Case Studies by Integrating QR Codes

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ABSTRAK

Biologi Sel merupakan matakuliah yang materinya bersifat abstrak karena tidak dapat diamati secara kasat mata. Permasalahan yang ditemukan pada pembelajaran Biologi Sel adalah belum adanya buku referensi yang dapat membuat materi abstrak menjadi lebih nyata sehingga dapat mempermudah pemahaman mahasiswa terhadap materi. Penelitian ini bertujuan untuk menganalisis kebutuhan mahasiswa terhadap buku ajar Biologi Sel interaktif berbasis Case Study *dengan mengintegrasikan* QR Code*. Penelitian ini merupakan penelitian deskriptif kuantitatif. Subjek pada penelitian ini adalah mahasiswa Pendidikan Biologi. Data diperoleh melalui wawancara, observasi, dan angket. Data dianalisis dengan cara deskriptif kuantitatif. Berdasarkan analisis data, 67,6% mahasiswa menyatakan bahwa mereka hanya dapat membayangkan struktur dan proses yang terjadi di dalam sel, 86,5% mahasiswa mengalami kesulitan memahami materi Biologi Sel. Hasil analisis data juga menunjukkan bahwa seluruh sampel setuju dikembangkan bahan ajar yang mengintegrasikan* QR Code *yang terhubung ke berbagai video ataupun literatur. Berdasarkan hasil tersebut dapat disimpulkan bahwa dibutuhkan pengembangan buku ajar Biologi Sel interaktif berbasis* Case Study *dengan mengintegrasikan* QR Code *lebih lanjut.*

ABSTRACT

Cell Biology is a course whose material is abstract because it cannot be observed with the naked eye. The problem in learning Cell Biology is that no reference books can make abstract material more real to facilitate students' understanding. This research aims to analyze students' needs for Case Study-based interactive Cell Biology textbooks by integrating QR Codes. This research is quantitative and descriptive. The subjects in this research were Biology Education students. Data was obtained through interviews, observations, and questionnaires. Data were analyzed using quantitative descriptive methods. Based on data analysis, 67.6% of students stated that they could only imagine the structures and processes in cells, and 86.5% needed help understanding Cell Biology material. The results of the data analysis also show that all samples agreed to develop teaching materials that integrate QR codes connected to various videos or literature. Based on these results, an interactive cell biology textbook based on case studies needs to be created by further integrating QR codes.

1. INTRODUCTION

Cell biology is one of the sciences that studies the structure and function of cells, which are the basic units of life. The principles of cell biology used for human interests can be applied in biotechnology. Biotechnology consists of conventional and modern biotechnology. Biological systems have influenced many biological disciplines, including biology in medicine (Dewi, 2023; Noviantari & Khariri, 2020). Cell Biology is a core course in the study program in the MBKM Curriculum of the Biology Education Study Program. This course discusses the development of cell discoveries, the general structure of prokaryotic, eukaryotic, and viral cells, the chemical and physical properties of protoplasm, the basic structure of cell membranes, the development of cell membrane models, the function of cell membranes, the components and builders of cytoplasm and cytoskeleton, mitochondria and chloroplasts as energy producers, DNA as genetic material for ribosomes and other organelles, the cell cycle and protein synthesis, growth and differentiation. The material studied in the cell biology course is abstract and uninteresting, so it is a

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challenge for lecturers to help students understand it (Hidayahtika et al., 2020; Soenarno & Sari, 2020). The object of study of Cell Biology is not only abstract, but it is also not possible to observe cells down to their organelles and genetic material with the laboratory equipment available because Jambi University does not yet have an electron microscope that students can use to observe cells (Hidayahtika et al., 2020; Soenarno & Sari, 2020). This affects students' understanding of the study material of this course. Students will guess what the organelles in the cell look like, how the genetic material is arranged, and what physiological processes occur in the cell. This may cause students to need to understand the cell material. Students need clarification about abstract and complex concepts (Suci, 2024; Wulandari, 2022). Students aged 16 to 19 still need adequate knowledge of cell structure and genetics-related materials. This can hinder understanding of subsequent materials because cell materials provide students with an understanding of life processes from the organism to the ecosystem (Husnita & Saputri, 2023; Mahrawi et al., 2021).

In this era of society 5.0, technological developments are occurring very rapidly. Technology and the internet are not only used to search for information but have become part of people's daily lives. The development of technology and the internet also greatly influences the world of education (Saputra et al., 2023; Sumadi et al., 2022). Teachers or lecturers can use technology and the internet to provide media to help pupils and students understand learning material. The concept of cell biology, which requires much memorization of scientific names, foreign terms, and pictures of the structural layout of cell parts, can be conveyed by lecturers through technology-based media (Rahayu, 2021; Shafa, 2022). Media development by utilizing existing technology can overcome students' difficulties in learning cells' concepts, structure, and function. In addition, lecturers will also be helped in the process of delivering material to students. Well-developed media will help students to learn well (Melanda et al., 2023; Zahwa & Syafi'i, 2022).

Lecturers can use technology and the internet to develop learning media to help students understand the study material in the Cell Biology course. With the help of technology and the internet, students can observe abstract Cell Biology material directly. This can be realized because technology can change abstract concepts into concrete ones with visualization. Lecturers can develop interactive media that contain various links that direct students to materials related to the study material being studied (Ali Akbar et al., 2023; Munandar et al., 2023). In today's digital age, the display of links is no longer just letters or numbers; it can also be used with a more attractive appearance and is based on current developments. When the QR code is scanned, a link will appear on the search engine, displaying further discussion of the studied material (Anam, 2024; Puspa et al., 2022). This discussion can be in articles or videos related to the material. Using QR codes in learning media can solve space limitations (Andini, 2024; Sianipar et al., 2023).

The rapid development of technology must also be supported by human resources who have good skills. 21st-century human resources must have 4C skills (communication, critical thinking, problem-solving, creative thinking and innovation, and collaboration) (Mas et al., 2021; Nurhalimah et al., 2024). However, as the next generation of human resources, students still need to gain 4C skills. Lecturers can help students improve their 4C skills by implementing learning using the case method (Mumtaziah & Abdul Majid, 2023; Nurhayati et al., 2024). The case method aims to support the development of students' critical thinking skills, problem-solving, and intellectual abilities. Critical thinking skills are very much needed amidst the rapid development of technology and the rapid flow of information. The case method has been proven to improve students' critical thinking skills. The case method effectively improves students' critical thinking skills (Muthmainnah et al., 2023; Rahmadi et al., 2022).

In learning with the case method, students are given a case or problem that generally occurs in everyday life. Then, they discuss it to find alternative solutions to solve the problem (Titis Madyaning Ratri et al., 2023; Vahlepi et al., 2021). With such learning experiences, students are expected to build their knowledge to improve the skills needed in the 21st century, namely 4C skills, especially critical thinking (Nurhayati et al., 2024; Septikasari & Frasandy, 2020). In addition to considerations in terms of material presentation, lecturers must also consider suitable media that can support the implementation of lectures that are carried out using the case method so that lecturers and students can be assisted in implementing lectures. A textbook can be developed to combine components in problems and various links in QR codes (Ali & Ali, 2024; F. Harahap et al., 2023).

The textbook contains links and problems related to the study material that students will complete. A textbook is a book that contains learning materials that are compiled and developed by experts in their fields. The textbook is compiled based on the curriculum and syllabus used. Because implementing Cell Biology lectures uses the case method, the textbook can provide cases or problems that students will solve during learning activities (Mellysa Barus, 2020; Suci, 2024). Cases or problems are presented at the beginning of each study material adjusted to the syllabus. QR Code links can also be added to the textbook to direct students to videos or materials that can explain the study material in more detail to prevent misconceptions due to abstract material (Anam, 2024; Oktiningrum & Putri, 2023). Before developing a case study-based textbook by integrating QR codes, conducting preliminary research on students' needs for

the product to be developed is necessary. This study aims to determine students' needs for an interactive Cell Biology textbook based on a Case Study by integrating QR codes to conclude the need for further product development.

2. METHOD

This research is a quantitative descriptive study, where data is collected directly from respondents through data collection instruments. The subjects of this study were students of the Biology Education Study Program, FKIP, Jambi University, Class of 2021, who had contracted the Cell Biology course. The research was conducted from May to June 2022. Data was collected through questionnaires and interview techniques. This study's first stage was interviewing students who contracted the Cell Biology course. Interview topics covered the teaching materials, student characteristics, and the curriculum used during learning. The topic of teaching materials includes questions about the availability of teaching materials, intensity of use, problems often faced, and students' expectations for the future. The topic of student characteristics includes questions about interest in Cell Biology, problems that often arise in learning Cell Biology, and students' expectations regarding learning Cell Biology in the future. The topic contains questions about the curriculum applied, the learning methods used, and problems generally faced. The next stage is filling out the needs analysis questionnaire by students who contracted the Cell Biology course. The purpose of filling out this questionnaire is to determine the types of teaching materials students need and the integration of QR Codes in teaching materials. The needs analysis questionnaire uses the Guttman scale. The answer "yes" is worth "1" and the answer "no" is worth "0". The results obtained were analyzed descriptively and quantitatively. The interpretation category of the percentage results of the needs analysis questionnaire can be seen in Table 1.

Table 1. Percentage Category of Needs Analysis Data

Percentage (%)	Category
0 – 1.9	Not needed
2 – 49.9	A small part needs
50	Half needs
50.1 – 99.9	Most needs
100	All needs

Suppose the questionnaire data analysis results show a percentage equal to or greater than 50%. In that case, teaching materials need to be developed. The entire data analysis's results are presented in descriptive form. The data to be described include the questionnaire results and interview interpretations.

3. RESULT AND DISCUSSION

Result

The results of interviews with students who contracted the Cell Biology course were divided into two topics, namely teaching materials and the curriculum used. The results of the interviews showed that the majority of students were interested in the topics studied in the Cell Biology course. However, they needed images and videos supporting the explanation to understand the material. The absence of images and videos to support the material meant that students could only imagine the structure and processes that occur in cells. Students expect teaching materials to support learning so that the topics studied in the Cell Biology course become easier and more interesting. The Biology Education Study Program at Jambi University implements the 2021 MBKM curriculum. The learning methods often used vary, including lectures, discussions, Team-Based Projects, and case methods. In this Cell Biology course, lecturers use the case method in learning, but there are obstacles in the form of a lack of teaching materials to support learning. The lack of teaching materials that support the implementation of the case method causes students' low understanding of the material being studied. In addition to not supporting the implementation of learning with the case method, the teaching materials owned by students need to contain supporting media. As many as 67.6% of students stated that they could only imagine the structure and processes that occur in cells without observing directly through various supporting media. Students' various teaching materials must still be equipped with media to support student understanding. 86.5% of students need help understanding the Cell Biology material in their learning resources.

Students stated that the teaching materials usually used by lecturers during cell biology learning are in the form of materials shared through PowerPoint presentations and learning videos from the YouTube application. These teaching materials are continuously delivered by lecturers using the help of a

projector. According to students, the teaching materials presented by lecturers using power points must be equipped with images and videos to explain the material in more detail. Students also need teaching materials to support learning with the case method.

It is expected that the development of teaching materials will be supported by videos that can explain the material in more detail so that students cannot only imagine the structure and processes that occur in cells. In addition, the development of teaching materials is also expected to include elements or steps of the case method to help implement learning in the classroom. Students also expect teaching materials with links directly connected to various videos and literature related to the studied material.

After interviewing students who contracted the Cell Biology course, a questionnaire was distributed to analyze the need for teaching materials. The results of the teaching material needs analysis questionnaire are shown in Table 2.

Table 2. Results of the Needs Analysis Questionnaire

No.	Indicator	Percentage (%)	Average PercentagePercentage (%)	Need Level Category
1.	The Cell Biology course requires teaching materials that can explain Cell Biology material more easily and interestingly	100	98.65	Most of them need
2.	The type of teaching materials needed are interactive textbooks	100		
3.	Case method-based textbooks	94.6		
4.	Textbooks contain links that can connect to various videos or literature that explain the material being studied in more detail with QR Code integration	100		

Table 2 shows that the average Percentage of student needs is 98.65%, so it can be interpreted that most students need teaching materials. The questionnaires filled out are supported by suggestions and comments from students that can be used as considerations in determining the teaching materials to be developed. Suggestions given by students include developing interesting or "eye-catching" teaching materials, containing materials that are by the syllabus used by the lecturer, equipped with videos and images that can support the material, and can support the implementation of learning using the case method.

Discussion

Based on interviews conducted with students, it is known that the media usually used by lecturers in Cell Biology courses are teaching materials presented in the form of PowerPoint and learning videos found on the YouTube application. The existence of these media still cannot support students' understanding of abstract Cell Biology material. This is supported by previous research, which stated that as many as 83% of students still need help to learn concepts in the material on cell structure and function. The results of the interviews also showed that there was a need for students to use interactive teaching materials that could make them understand the abstract Cell Biology study objects better. Abstract study objects can be changed into concrete study objects through visualization with the help of technology. Through the help of technology, lecturers can develop interactive learning media that can be used in learning. The use of interactive media in learning has its appeal in that it can motivate students to be more active and critical in answering problems related to the material being studied (Afifah & Asri, 2020; Harlis et al., 2024).

So far, the learning process is known to only partially guide students in solving problems. Learning with the case method is learning that presents contextual problems so that it can stimulate students to think actively in solving problems so that learning becomes more meaningful. The case method focuses on problems that exist in certain situations or circumstances, actions that must be taken to solve problems, and actions to avoid similar situations in the future. The case method influences the increase in student learning motivation (Nurirdasari, Muhammad Khalifah Mustami, 2023; Rizkina et al., 2023). If students are motivated to learn, then learning outcomes will also increase. The case method is one that lecturers can use to create interesting learning and help students understand the material (Andayani et al., n.d.; Rizkina et al., 2023). The case method aims to help students understand and master the material, increase student activity and independence, and train students in analyzing and solving problems. The presentation of problems

through applying the case method in learning increases students' sensitivity to social issues and raises an attitude to take a role in overcoming these issues (Akhyaruddin, 2022; Jamaludin & Alanur, 2021; Sofia et al., 2023).

Learning success is determined by the method and the media or learning resources used. Both components are interrelated. The choice of method will also affect the media or teaching materials used. The case method can be applied directly to learning and poured into learning media, such as textbooks (Husnita & Saputri, 2023; Mahrawi et al., 2021). Textbooks are expected to help educators in applying learning steps in the classroom. However, the media usually does not support the implementation of learning using the case method. This can make it difficult for lecturers if they have to prepare worksheets and media for students every time they carry out cell biology learning with the case method, so the lecturer's preparation for implementing learning becomes less mature. This less mature preparation of lecturers can also impact the proper implementation of the learning process. An educator should be able to design a good and correct textbook to create an interactive, inspiring, fun, challenging, and motivating learning environment in which students can be actively involved (Mahrawi et al., 2020; Sianipar et al., 2023). Active student involvement can provide space for creativity and independence according to their talents, interests, and psychological development. Teachers must prepare books, teaching aids, questions, and directions to encourage student activity before learning begins. This can be described in the textbook (Oktiningrum & Putri, 2023; Yuliana & Atmojo, 2020).

The 21st century is a digital era where the development of digital technology impacts the world of education, including the shift in education patterns from the millennial generation to Generation Z, which currently occupies the undergraduate level of education. The education pattern of Generation Z is very different from the education pattern of the previous generation, so innovation is needed to adjust to the needs of this generation Z (Nurihsan, 2012; Subandowo, 2022). The needs of Generation Z, who always depend on smartphones, can be utilized for the development of learning media that will be used. The learning media must also be able to train critical and innovative thinking skills and students' problem-solving abilities to be accustomed to facing problems or issues in everyday life (Ghafara et al., 2023; Yogyakarta, 2024).

Students hope that the development of interactive teaching materials will help them understand the object of study of cell biology well and, simultaneously, support the implementation of learning using the case method (Firdaus et al., 2022; Mellysa Barus, 2020). The developed learning media is also expected to contain elements such as complete materials, clear and supportive images, and elements that make the media interactive and can connect students to video links or materials that support the object of study being studied. The results of this study show that teaching materials have a very important role in learning activities (Harlis et al., 2024; Mahrawi et al., 2020). This is in line with previous research, which found that teaching materials consist of all types of materials used to support the learning process in the classroom. If there are problems with teaching materials, the learning process will not run optimally (Mahrawi et al., 2021; Sianipar et al., 2023).

Based on the interviews, most students consider the topics in the Cell Biology course interesting to learn. The abstract topic becomes difficult to understand when there is a lack of clear and interesting images and videos that support the material. Revealing that image media effectively improves learning achievement (Hakim & Yulia, 2024; Yohanes, 2022). The teaching materials to be developed must overcome these difficulties, for example, by inserting videos that students can watch directly or various literature that can support their understanding. If associated with the use of digital technology and the needs of Generation Z for digital technology, educators must be creative in developing teaching materials that contain digital elements, for example, by integrating QR Codes that can connect students to video links that contain more complete and real explanations related to the material being studied. QR Code is a tool or aid that can make it easier for users to access videos or additional literature inserted into teaching material. QR Codes can create an interactive and enjoyable learning experience (M. S. Harahap et al., 2023; Oktiningrum & Putri, 2023). In addition, QR Codes that connect students to various videos that can support the explanation of the material can improve students' understanding. Delivering material in videos can make it easier for students to understand and make them more enthusiastic in the learning process. The use of audio-visual media can increase students' interest and motivation. If students' interest and motivation are high, their learning outcomes will also be high (Ataji, 2019; Azhari & Armanda, 2018).

In addition to integrating QR Codes that can connect students to various supporting material links, the teaching materials must also support the implementation of learning with the case method so that students can be trained to solve various problems and build their knowledge. This research is also supported by previous research, which found that case method-based learning can increase student involvement in the learning process so that learning becomes more active and can train students' high-level thinking skills. This opinion is supported by the results of other studies, which conclude that students are

interested in learning activities that use QR Codes (Harlis et al., 2024; Sianipar et al., 2023). Problem-solving activities carried out by students in learning can train students to think critically and creatively, thus impacting better learning outcomes. Problem-based learning with the QR Code can improve student learning outcomes (Hidayati, n.d.; Kusumaningtyas & Hakim, 2020).

After conducting the interviews, a needs analysis questionnaire was distributed to students. This questionnaire was filled out by 37 Biology Education students from the 2021 intake who had contracted the Cell Biology course. Based on the analysis results, most students need teaching materials to help them learn cell biology. Students expect interesting teaching materials in the form of interactive textbooks that can help them learn using the case method according to the syllabus used. The need for teachers and students for interactive textbooks is 100%. The developed interactive textbooks are expected to have various elements such as clear and interesting images and videos that can help students understand the studied Cell Biology material so they can no longer imagine the structure and processes that occur in cells but can see them directly. This will have a positive impact on the process and learning outcomes of students. Learning videos positively impact learning activities such as material presentation, motivation, tutorials, and effectiveness in using time. Based on the analysis that has been carried out, it can be stated that students need interactive teaching materials that can support learning using case studies (Nursela et al., 2021; Suwarni, 2020).

This study is limited to only looking at students' needs for interactive case study-based textbooks by integrating QR Codes. Further research is expected to develop case study-based textbooks by integrating QR codes to help lecturers and students learn, especially the Cell Biology course. This study has advantages, such as using a case study, which makes learning more interesting and relevant to the real-world context, thus motivating students to learn better. QR Code integration enriches the experience with direct access to additional content such as videos, images, or related articles. In its implementation, each case study or topic explained in the textbook is equipped with a related QR Code. QR Codes can be implemented to access videos, simulations, articles, or other additional resources that support understanding of the material. However, this study still has limitations. Although QR codes offer easy access to additional content, they depend on the sustainability of the technology. If the QR Code is damaged or inaccessible due to technical problems, this can interfere with the learning experience.

4. CONCLUSION

Based on the research, students need interactive Cell Biology textbooks that can support the implementation of learning with case studies by integrating QR Codes. Integrating QR Codes in Cell Biology textbooks can increase student interactivity and engagement in learning. QR Codes allow direct access to additional content, such as videos, simulations, or articles supporting the material's understanding. Combining interactive textbooks, Case Studies, and QR Codes can increase students' motivation and involvement in the learning process. Students feel more involved because the material is presented in an interesting and relevant way.

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