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Development of 21st Century Skills Integrated Mini Research E-Assessment for Prospective Teacher

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Abstract: The E-Assessment is designed by lecturers as an evaluation instrument for prospective teachers conducting mini-research to support 21st-century skills. The research method used is Research and Development (R&D) with the ADDIE research design. The research sample consists of 50 students enrolled in the Biology Education FKIP Universitas Kuningan. Data collection was conducted through observations to identify problems and assessment needs, questionnaires for expert validation, and feedback from lecturers as users.The E-Assessment was developed using Microsoft Excel and iSpring Suite Maker, featuring a mini-research task on Endocrinology learning, a rubric for assessing 21st-century skills indicators, and cognitive questions. The results of media expert validation indicated that the product is highly feasible (89%), evaluation experts rated it as very feasible (91%), and subject matter experts rated it as very feasible (88%). Based on lecturer responses, the product is practical and effective for use (81%), while the achievement of 21st-century skills using the developed E-Assessment is 87.54%. This indicates an improvement in the 21st-century skills of students through mini-research assessed using the developed E-Assessment. Based on these results, it can be concluded that the developed product can serve as an alternative digital-based authentic assessment that lecturers can use to evaluate students' 21st-century skills.

Keywords: Authentic assessment; E-assessment; Mini research; 21st century skills

Introduction

The 21st century requires human resources with competencies in the fields of science, technology, communication, and the ability to solve complex problems (Milaturrahmah et al., 2017). The skills of the 21st century include essential skills, innovation skills, and skills in information technology and communication (Sondergeld & Johnson, 2019; Saputri et al., 2022), such as critical thinking and problem-solving, creative thinking and innovation, communication, and collaboration. 21st-century learning should be able to build comprehensive abilities of students that are highly needed in life (Awaliyah & Rusmini, 2023; Malagola et al., 2023).

It is important for prospective teacher students to be equipped with 21st century skills to support their competence. Students need to construct knowledge, think critically, be creative and have the ability to solve problems (Iskandar et al., 2022). Effort made to enhance 21st-century skills is through mini research-based learning. Mini research facilitates students in constructing knowledge and solving problems through scientific methods (Daulae & Napitupulu, 2018). Learning using mini research has been proven to enhance integrated scientific knowledge and problem-solving skills of students (Setiawati et al., 2022). It also facilitates students' skills in writing scientific articles and communication (Haryono & Adam, 2021).

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The majority of study programs at FKIP only measure competencies according to course learning outcomes which emphasize more on cognitive aspects so that the profile of 21st Century skills in prospective teacher students These have not been measured using appropriate instruments. The lecturers have not yet utilized authentic assessment to measure the cognitive, affective, and psychomotor aspects integrated into learning. They have also not utilized technology-based assessment to facilitate the creation of student portfolios as feedback on learning. Assessment to evaluate student competencies should encompass cognitive, affective, and psychomotor aspects, so tests alone cannot measure all these aspects (Sudirman et al., 2023). Efforts made in addition to applying appropriate learning techniques also require appropriate authentic assessments, namely assessments that emphasize feedback on student performance by integrating technology (Darling-hammond et al., 2010), using meaningful or authentic real-world problem contexts and assignments in the form of projects (Lai & Viering, 2012).

The assessment that will be developed in this research is a mini research E-Assessment that is integrated with 21st Century skills. Assessment is needed to measure learning achievements and as an evaluation of the quality of the learning carried out (Faisal et al., 2023). E-Assessment is important to develop in line with the development of 21st Century skills (Astalini et al., 2019). Technology-based assessments will be more accessible and interesting for students (Crisp, 2010). E-Assessment by applying project creation is an effective alternative assessment alternative (Crisp, 2010).

The demands for curriculum development in schools require teachers to have competencies, one of which is 21st Century skills (Ichsan et al., 2023). This has an impact on the implementation of learning in LPTK which results in prospective teachers being able to develop 21st Century skills both through learning and the use of assessments. The increasingly rapid development of technology requires learning and evaluation to utilize technology to be more efficient in its use. The novelty of this research lies in the E-Assessment developed based on mini research, where prospective teacher students are trained to conduct small scale research and prepare scientific reports on the research they have conducted. The assessment is made comprehensively to assess cognitive, affective and psychomotor where each of these competencies is activated with 21st Century skills. The novelty in this research is the development of E-Assessment based on mini research, where prospective teacher students are trained to conduct small-scale research, compile scientific reports, and communicate their research results. At each stage, assessments are made that are integrated with the 21st-century skills of students, providing a comprehensive picture of each indicator of the students' 21st-century skills.

Method

The research method used in this study is Research and Development (R&D). The stages of the research method, namely the ADDIE model, include analysis, design, development, implementation, and evaluation developed by Reiser and Molenda (Molenda, 2003). The ADDIE model was chosen because this model has the advantage of a simple model but its implementation is systematic. Each phase is evaluated and revised from its stages, so that the resulting product becomes a valid product. The focus of this research is analysis from start to finish, which includes Analysis, Design, Development, Implementation and Evaluation. This can be illustrated as in Figure 1 below.

Figure 1. ADDIE model research design

Based on the picture, The stages of ADDIE research include; 1) Analysis: the first stage is to analyze the need for product development in the form of E-Assessment which is designed as an evaluation instrument for prospective teacher students in conducting mini-research developed to support the formation of 21st century skills and analyze the feasibility and requirements in developing this product. The development of this product began with the problem of the need to develop 21st century skills in prospective biology teacher students. There is no mini-research assessment instrument for prospective teacher students that is integrated with 21st century skills. The instrument is able to assess the mini-research activities of prospective teacher students and 21st century skills which include critical thinking, creativity, communication and collaboration skills. 2) Design: This design activity begins with designing the concept and content in the 21st century skills-based mini-research E-

assessment product. The concept of this assessment is how to develop an assessment instrument in mini-research activities. Then the assessment is focused on the 21st century skills of prospective teacher students. Furthermore, designing a draft instrument that assesses critical thinking, creativity, communication and collaboration skills by determining indicators/criteria, scales/scores, and descriptions of criteria written clearly and in detail. The e-assessment product design is still conceptual. 3) Development: Development in this study contains the activities of realizing the design of the mini-research e-assessment product using the i-spring application, by creating Tasks/assignments accompanied by assessment rubrics that can directly produce results/conclusions from the 21st century skills values of prospective teacher students. Furthermore. Producing programs by developing an assessment application using i-Spring Suite 11 which is used in making the mini-research e-assessment. The features used are quiz applications, web objects and interaction. At this stage, an instrument is also created to measure product performance in the form of a validation sheet from the expert team. 4) Implementation: the implementation of the integrated mini-research E-assessment product of 21st century skills in this study is intended to obtain feedback on the product that has been created/developed. Initial feedback (initial evaluation) can be obtained by asking questions related to the purpose of product development. The implementation is carried out referring to the product design that has been created using a questionnaire for lecturers who use the instrument. And used to assess the 21st century skills of prospective teacher students. 5) Evaluation: the evaluation stage in this study was carried out to provide feedback to product users, so that revisions were made according to the evaluation results or needs that have not been met by the product. The final goal of the evaluation is to measure the achievement of the development objectives in this study.

The trial subjects on the products that have been developed will be tested on prospective Biology teacher students with a total of 50 students. The trial in this study was only carried out at the small group trial stage. The types of data in this study are in the form of qualitative descriptive and quantitative descriptive data. The qualitative data used in this study were obtained from validator input from the results of product validation by 3 validators from evaluation experts, material experts and media experts as well as comments and input from lecturers. Quantitative data were obtained from the results of a validation questionnaire on products from 3 experts, a questionnaire of lecturer and student responses. Data collection techniques from the study were by using questionnaires and 21st century skills tests. The questionnaires in this study were: 1) Validation questionnaire from material validators; 2) Validation questionnaire from evaluation expert validators; 3) Validation questionnaire from media expert validators; 4) Response questionnaire or responses given to lecturers; 5) Student response questionnaire. The questionnaire instrument contains statements about the practicality, usefulness, and ease of e-assessment mini-research based on 21st century skills. The 21st century skills test includes; critical thinking skills, creative thinking, collaboration and communication. The instruments used in this study have been tested for validity and reliability, using SPSS. The data from the questionnaire sheet test obtained the reliability value of the questionnaire using Cronbach's alpha, which is 0.76 and the average value of the validity of the "valid" category items.

The test results data of the 21st century skills test instrument obtained the reliability value of the questions using Cronbach's alpha, which is 0.85 and the average validity value of the question items in the "valid" category. The data collected were analyzed quantitatively.

Data analysis in this research uses qualitative and quantitative data analysis techniques according to Miles et al. (1992) which consists of four stages, namely: data collection, data reduction, data presentation, drawing conclusions/verification. Data collection was carried out based on research instruments using observation sheets, questionnaire sheets, expert team validation sheets and 21st century skills tests. Data reduction is carried out to summarize data from observations, questionnaires, validation and tests to provide a clearer picture and focus on the need for developing mini-research-based e-assessments. Data reduction is carried out by processing the data. Data processing from the validation sheet is carried out by calculating the percentage of answers from experts. The validation sheet answers use the Guttman scale which consists of two alternatives in the form of a checklist (√). Eligible answers include the highest score, namely 1, and Inappropriate answers include the lowest score, namely 0. The formula used to calculate the data percentage is as follows:

$$P = \frac{\sum x}{\sum xi} \times 100\% \quad (1)$$

Information:

P = Percentage score
$\sum x$ = Total scores obtained
$\sum xi$ = Ideal score total
100% = Absolute number

Interpretation of calculated data in this study refers to the following assessment criteria:

Table 1. Assessment Qualification Criteria

Percentage	Validation Level
81%-100%	Very Worthy
61%-80%	Worthy
41%-60%	Quite Decent
21%-40%	Not feasible
Less than 20%	Totally Unworthy

Data presentation is carried out by collecting structured information to provide the possibility of drawing conclusions and taking action. The findings are then described to make them more systematic and easy to understand. At this stage, data validation is carried out where the validator will provide input regarding the shortcomings of this assessment application so that it can then be refined/revised. Drawing conclusions is an activity of complete configuration based on the results of data presentation and the results of data processing. Conclusions were also verified during the research.

Result and Discussion

The result of the research development is an E-Assessment based on a mini research integrated with 21st-century skills for prospective teacher students using the ADDIE development model, which consists of Analysis, Design, Develop, Implementation, and Evaluation. In the Analysis phase, the researcher conducted a needs analysis regarding the digital-based assessments needed to support 21st-century learning for students and analyzed issues regarding the availability of authentic digital assessments and the achievement of students' 21st-century skills. In the Design phase, the researcher developed the assessment plan, which includes creating tasks that require students to conduct mini research, defining indicators for the four types of 21st-century skills, with each indicator adjusted to the stages of mini research, preparing a scoring rubric based on the 21st-century skills indicators, designing a test containing cognitive questions to measure students' 21st-century skills, and creating a questionnaire for validators, as well as responses from lecturers and students about the developed assessment.

The indicators of collaboration skills include contributing actively, working productively, showing responsibility, flexibility, compromise, and mutual respect in collaboration (Sugiharto & Hidayati, 2022). The indicators of oral communication skills involve material presentation, language use, gestures, question management, and effective use of time. The indicators of critical thinking skills are identifying problems, determining solutions, reconstructing and evaluating arguments, and drawing conclusions. The indicators of creative thinking skills are generating multiple ways or ideas to solve problems, seeking alternatives, and thinking differently (Marwiyah et al., 2015). In the Develop phase, the researcher integrated all the content created in the previous phase using the iSpring Suite Maker application. This involved structuring tasks in the form of a PowerPoint presentation that included links to interactive features, quizzes/cognitive questions, and a complete scoring rubric. During this phase, product validation was also carried out by validators from three fields: media, evaluation, and endocrinology. The use of technology like iSpring Suite can increase student engagement and ease the lecturers' tasks in the teaching and assessment process (Agustina, 2022). The flexibility of using iSpring Suite, which is not limited to laptops but also accessible via Android devices, demonstrates that technology like iSpring Suite has the potential to enhance learning effectiveness by enabling easier and more flexible access (Mutia et al., 2024). The display of the E-Assessment using iSpring Suite Maker is presented in Figure 2.

Figure 2. Display of the iSpring suite task and mini research stages

Figure 2 shows one of the tasks created for the sub-topic of the Pituitary Gland (ADH Hormone) and the steps to complete it using the mini research stages. Figure 3 shows the 21st Century Skills E-Assessment based on mini research, which includes a scoring rubric using Microsoft Excel, complete with criteria and

formulas, allowing lecturers to easily assess all 21st-century skills indicators and obtain the overall student achievement results. It also shows the display of the quiz/cognitive test to measure 21st-century skills. This E-Assessment can be used as feedback for the mini research learning process to determine whether it facilitates the development of students' 21st-century skills. The Excel display, which includes all aspects of the 21st-century skills assessment, is presented in Figures 4-6.

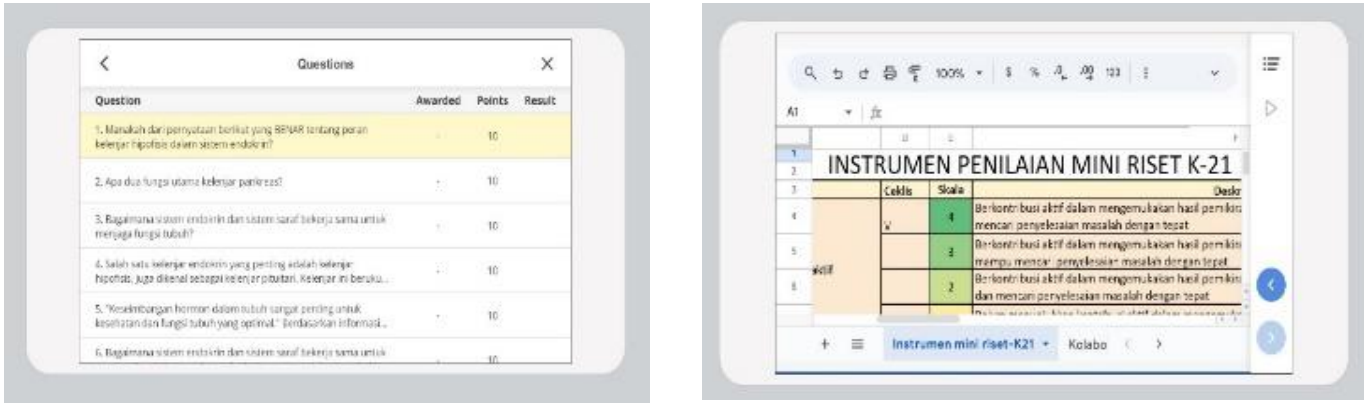


Figure 3. Display of the iSpring suite cognitive test and 21st century skills scoring rubric

INSTRUMEN PENILAIAN MINI RISET K-21

Kriteria	Indikator	Ceklis	Skala	Deskripsi	Skor	Keterangan
KETERAMPILAN KOLABORASI	Berkontribusi secara aktif	V	4	Berkontribusi aktif dalam mengemukakan hasil pemikiran, mampu menyatukan hasil diskusi dan mampu mencari penyelesaian masalah dengan tepat	4	Unggul
			3	Berkontribusi aktif dalam mengemukakan hasil pemikiran, mampu menyatukan hasil diskusi namun belum mampu mencari penyelesaian masalah dengan tepat		
			2	Berkontribusi aktif dalam mengemukakan hasil pemikiran, namun belum mampu menyatukan hasil diskusi dan mencari penyelesaian masalah dengan tepat		
			1	Belum menunjukkan kontribusi aktif dalam mengemukakan hasil pemikiran, dan belum mampu menyatukan hasil diskusi serta mencari penyelesaian masalah		
	Bekerja secara produktif	v	4	Aktif melakukan diskusi untuk menyelesaikan tugas secara efektif dan efisien, fokus berdiskusi dalam pencarian solusi serta komunikasi lancar dalam diskusi.	4	Unggul
			3	Aktif melakukan diskusi untuk menyelesaikan tugas secara efektif dan efisien, fokus berdiskusi dalam pencarian solusi namun belum menunjukkan komunikasi lancar dalam diskusi.		
			2	Aktif melakukan diskusi untuk menyelesaikan tugas secara efektif dan efisien, namun belum fokus berdiskusi dalam pencarian Solusi serta belum menunjukkan komunikasi lancar dalam		
			1	Belum menunjukkan keaktifan dalam melakukan diskusi, belum focus dalam pencarian Solusi dan belum menunjukkan komunikasi lancer dalam diskusi		
	Menunjukkan tanggung jawab		4	Memiliki tanggung jawab terhadap penugasan yang diberikan, menyelesaikan tugas tepat waktu, dan mematuhi instruksi yang diberikan	3	Kompeten
		v	3	Memiliki tanggung jawab terhadap penugasan yang diberikan, menyelesaikan tugas tepat waktu, namun belum mematuhi instruksi yang diberikan		
			2	Memiliki tanggung jawab terhadap penugasan yang diberikan, namun belum menyelesaikan tugas tepat waktu, dan belum mematuhi instruksi yang diberikan		
			1	Belum Memiliki tanggung jawab terhadap penugasan yang diberikan, belum menyelesaikan tugas tepat waktu, dan belum mematuhi instruksi yang diberikan		
	Menunjukkan fleksibilitas dan kompromi		4	Menerima kritik dan saran untuk perbaikan mampu mendiskusikan perbedaan pendapat dan menyelesaikan penugasan yang diberikan dengan tepat	3	Kompeten
		v	3	Menerima kritik dan saran untuk perbaikan mampu mendiskusikan perbedaan pendapat namun belum menyelesaikan penugasan yang diberikan dengan tepat		
			2	Menerima kritik dan saran untuk perbaikan namun belum mampu mendiskusikan perbedaan pendapat namun belum menyelesaikan penugasan yang diberikan dengan tepat		
			1	Belum mampu Menerima kritik dan saran untuk perbaikan, belum mampu mendiskusikan perbedaan pendapat dan belum menyelesaikan penugasan yang diberikan dengan tepat		
			4	Menghargai dan menghormati pendapat teman dalam diskusi, tidak memaksakan pendapat dan menerima keputusan bersama dalam penyelesaian masalah		

Instrumen mini riset-K21 | Kolaborasi | Komunikasi | Berpikir Kritis | Berpikir Kreatif

Figure 4. 21st century skills checklist instrument

Rekapitulasi Skor Hasil Penilaian Keterampilan Berpikir Kritis

No	Keterangan	Jumlah	%	Skor ya
1	Skor 4	3	60,00%	12
2	Skor 3	2	40,00%	6
3	Skor 2	0	0,00%	0
4	Skor 1	0	0,00%	0
		5	100,00%	18

Hasil Penilaian Keterampilan Berpikir Kritis

No	Keterangan	Skor Seharusnya	Skor Dicapai	%
1	Hasil Penilaian Keterampilan Berpikir Kritis	20	18	90,00%
2	Deskripsi Kinerja	Sangat Baik		

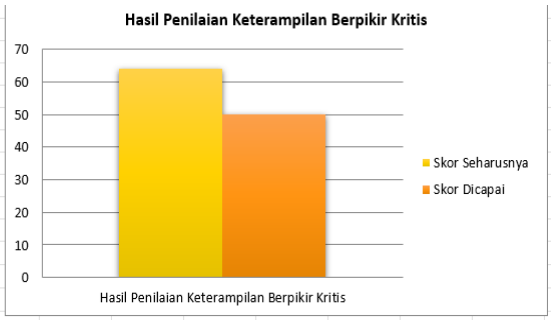
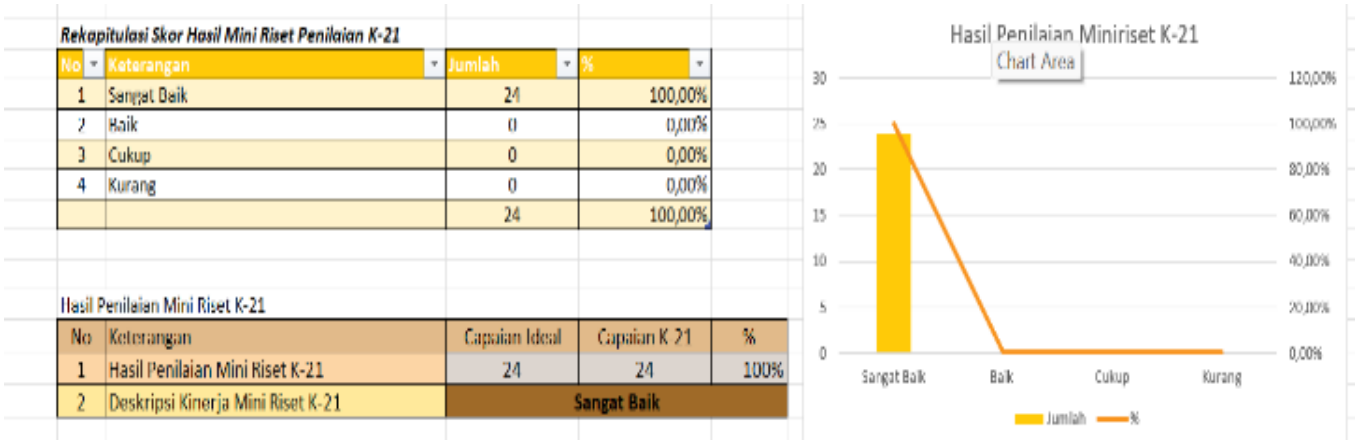


Figure 5. Recapitulation of critical thinking skills assessment



Rekapitulasi Skor Hasil Mini Riset Penilaian K-21

No	Keterangan	Jumlah	%
1	Sangat Baik	24	100,00%
2	Baik	0	0,00%
3	Cukup	0	0,00%
4	Kurang	0	0,00%
		24	100,00%

Hasil Penilaian Mini Riset K-21

No	Keterangan	Capaian Ideal	Capaian K 21	%
1	Hasil Penilaian Mini Riset K-21	24	24	100%
2	Deskripsi Kinerja Mini Riset K-21	Sangat Baik		

Figure 6. Results of the 21st century skills assessment

In the Develop phase, the next step is to conduct a validation test by three experts in the fields of media, evaluation, and content. The results of the expert validation are presented in Table 2, where the media expert stated that the design of the E-Assessment created is attractive, complete, and easy to use with a percentage of 89% (very feasible). Table 3 explains the results of the evaluation expert validation with a percentage of 91% (very feasible), stating that the scoring rubric is comprehensive and measures each indicator of 21st-century skills. This is in accordance with the research by Ningsih et al. (2023) which stated that assessments must meet aspects of content, assessment characteristics, and the completeness of the scoring rubric to be considered valid. However, the validator suggested limiting the assessment of communication to oral communication only, as written communication has already been assessed through the preparation of the mini research report, which is integrated with critical and creative thinking skills, both of which are part of the 21st-century skills.

The results of the material validation by the Endocrinology expert (Table 3) have met the aspects of content, mini research characteristics, as well as the integration of mini research and 21st-century skills, with a very feasible or valid rating (88%). The material validation results indicate that the problems presented in the E-Assessment are contextual and represent several endocrine glands that can be addressed using the mini research stages with an experimental method. Based on the validation results from the three experts, it can be concluded that the product is feasible to be used in the pilot testing phase of Endocrinology learning.

Table 2. Media Expert Validation

Aspect	Percentage	Criteria
Language	90%	Very worthy
Graphics	85%	Very worthy
Design	92%	Very worthy
Total	89%	Very worthy

Table 3. Validation of Material Experts Evaluation

Aspect	Percentage	Criteria
Content	95%	Very worthy
Characteristic of ability 21st century	90%	Very worthy
Completeness of assessment	88%	Very worthy
Total	91%	Very worthy

Table 4. Validation of Mini Research Material Experts Endocrine

Aspect	Percentage	Criteria
Content	90%	Very worthy
Characteristics of mini research	90%	Very worthy
Integration of mini research and 21st century skills	85%	Very worthy
Total	88%	Very worthy

The next phase is the Implementation phase, which involves applying the E-Assessment in Endocrinology learning, covering the Pituitary Gland, Thyroid Gland, and Pancreas. Endocrinology learning integrates mini research, requiring students to conduct research according to the tasks in the iSpring Suite. Endocrinology learning applies mini research, and previous research has shown that mini research can enhance integrated KPS (Critical Thinking Skills) and problem-solving abilities of students (Widiantie et al., 2021). Students' 21st-century skills are assessed through the research conducted and through the quizzes/cognitive tests included in the developed E-Assessment.

After the implementation phase, an evaluation was conducted on the application of the product in Endocrinology learning, with responses from users, including two Endocrinology lecturers and 50 students, to assess their feedback on the developed product. The results of the lecturer feedback questionnaire are presented in Figure 7, where the lecturers provided a positive response to the product with an average of 81%. This means that the lecturers stated that the E-Assessment facilitated easy and practical authentic

assessment of students' 21st-century skills, and the E-Assessment was effective for use in learning that integrates mini research to facilitate students' 21st-century skills. This aligns with the requirement that lecturers must prepare appropriate learning strategies, media, and assessments to meet the demands of 21st-century skills (Syahfitri, 2023).

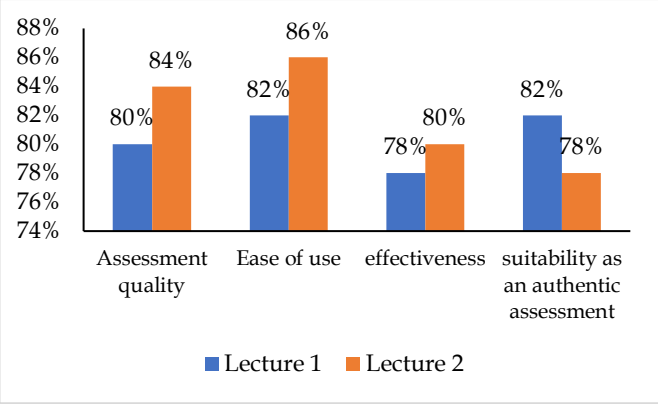


Figure 7. Results of the lecturer response questionnaire

An evaluation was also conducted on student responses (Figure 8), where students provided a positive response to the use of the assessment in learning. Students stated that the developed E-Assessment is comprehensive, with clear instructions at each stage and easy accessibility. Meanwhile, the results of the evaluation of students' 21st-century skills (Figure 9), assessed using the developed E-Assessment, were categorized as excellent, with the highest achievement being in collaboration skills at 94%. This indicates that mini research learning can facilitate the enhancement of students' 21st-century skills, as by conducting mini research, students are trained to collaborate responsibly, communicate their mini research results using appropriate presentation techniques, and create mini research reports that require critical and creative thinking skills. Prospective teachers must possess 21st-century skills so that they can work collaboratively, think innovatively, and solve real-world problems (Mukaromah et al., 2022).

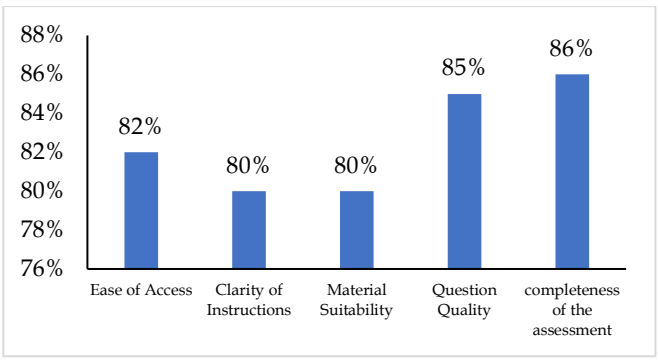


Figure 8. Student response results

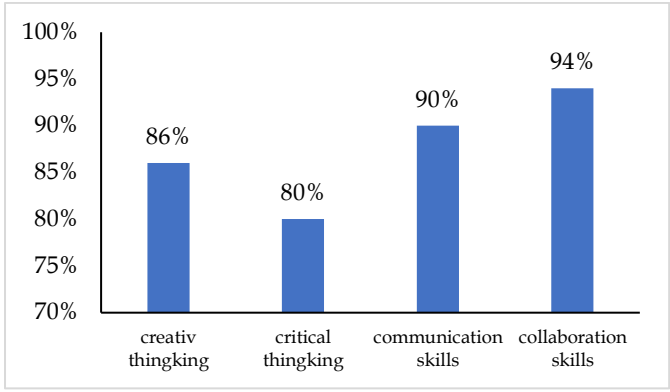


Figure 9. Achievement of 21st century skills

Lecturers must be innovative and adaptive to technological advancements integrated into the implementation of learning to facilitate students' 21st-century skills (Maulana et al., 2022). One way to achieve this is by preparing technology-integrated assessments. The developed mini research E-Assessment integrated with 21st-century skills can be used as an alternative authentic assessment for lecturers in Biology learning, especially to train students to apply research in practical activities and assignments. This allows lecturers to easily assess according to the indicators of collaboration, communication, critical thinking, and creative thinking skills comprehensively, and to evaluate students' achievements both individually and in groups, thus making it easier for lecturers to create portfolios of students' 21st-century skills achievements. In line with the research Azarpira et al. (2012) on science learning, particularly in Biology, in addition to using the appropriate method, it must be integrated with authentic assessment that evaluates students' achievements in integrating their thinking skills. Lecturers must equip students, particularly prospective teachers, with critical and creative thinking skills as part of their 21st-century skills to produce graduates who are skilled in problem-solving and adaptable to the development of 21st-century learning (Syahfitri, 2023).

Conclusion

The developed mini research E-Assessment integrated with 21st-century skills received an average validator score of 89% (very feasible), with lecturer responses to the use of the E-Assessment in the course at 81%, and student responses at 83%. These results can be concluded that the E-Assessment is feasible and effective for use by lecturers in teaching that integrates mini research and 21st-century skills. The developed E-Assessment contributes as a digital-based authentic assessment that can be used by lecturers in the Biology Education program. The novelty of the developed product is that the E-Assessment integrates the mini

research stages with 21st-century skills, allowing lecturers to obtain the 21st-century skills profile of students through mini research learning.

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Author Contributions
I.S, R.W, E.J, devised E-Assessment mini research integrated 21st Century Skills, I.S methodology and; R.W Compiling E-Assessment and analysis, E.J create validity instruments; R.W; writing original draft article about development E-Assessment mini research integrated 21st Century Skills for Prospective teacher, I.S, E.J and S.F.A; review and editing, R.W.; administration & funding acquisition.

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Conflicts of Interest
The research team stated that no conflict of internal and LPPM Universitas Kuningan had no role in the designing the study; in the data collection, analysis, or interpretation of data; make of scriptwriting; or in making decisions to publish research results in this Journal.

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