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Validity of Creative Interactive-Web and Seamless Learning Media and Learning Models to Improve Students' Creative Thinking Skills and Cognitive Learning Outcomes in High School Biology Subjects

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Abstract: This research aims to determine the validity of the Creative Interactive - Web And Seamless (CRI-WES) media and learning model. Development in this research uses the Wademan model which has five stages of development, namely problem identification, identification of tentative products and design principles, tentative products and theories, prototyping and initial product and theory assessment, and problem solving and theory development. The results of the biology education expert's validity analysis for content and construct validation showed a reliability percentage of 100% (R>75%). Biology education experts' validation of learning tools is included in the category of very valid, valid and sufficient to support learning with the CRI-WES model. Shows that the assessment tools and instruments are truly valid for use and do not require revision. This research produces an innovative learning model that is valid and can be used to assess practicality and effectiveness. This can also be applied to improve students' creative thinking abilities and cognitive learning outcomes in biology subjects at the high school level.

Keywords: Creative interactive; Learning media; Learning models; Seamles learning and web; Validity

Introduction

The concept of *Merdeka Belajar* is very different from the curriculum that has been used by formal education in Indonesia. This new educational concept considers the abilities and uniqueness of individual students (Wahyudi et al., 2023). *Merdeka Belajar* means that teachers and students have the freedom to innovate and learn independently and creatively. *Merdeka Belajar* can be used as a solution because policies are designed based on the wishes and prioritize the needs of students (Suyitno et al., 2023). Nadiem Anwar Makarim urged school teachers to design project-based learning methods to spur student creativity. The application of project-based learning can make students more active and focused on solving problems and students are able to practice thinking individually and in groups (Herowati, 2023).

The results of the PISA and TIMSS surveys show that the implementation of learning in the field of science in Indonesia can be more optimal. Students must have high creativity in thinking. Likewise, learning in the field of science requires high creativity. Creative thinking process and creative thinking skills are very important in learning science, especially biology. Anwar et al. (2012) revealed the importance of creative thinking skills, namely as a way to generate ideas that can be applied by teachers, especially in the field of science in

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the area where teachers teach (Anwar & Aness, 2012). The ability of creativity is an important skill that students must have to compete in the era of globalization, especially facing technological developments, namely Society 5.0 in 2021 (Kahar et al., 2021). Barry et al. (2006) stated that there are three components that make up creativity, namely creative people, creative processes, and creative products. The creative process is the initial process that involves creative people until it ends with a creative product. The creative process includes thoughts and actions to produce new products (Barry & Kanematsu, 2006). In line with research from Nenohai et al. (2022) regarding the development of game platforms in science subjects that are in great demand by students so that they affect their learning outcomes, the results of the media validity value of 94% which means it is very feasible to use (Nenohai et al., 2022).

Learning science requires students' creative thinking skills during the day (Siang et al., 2020). Creative thinking processes and creative thinking skills are very important in learning science, especially biology. Anwar et al. (2012) revealed the importance of creative thinking skills, namely as a way to generate ideas that can be applied by teachers, especially in the field of science in the area where teachers teach (Anwar & Aness, 2012).

The learning process applied by teachers by providing creative thinking skills in science learning, especially biology, can make a significant and positive contribution to the personal, social, technological, and economic development that will be applied by students as adults in the 21st century (Diawati et al., 2017; Mulyono, 2018; Trnova, 2014). One of the learning models that applies creative thinking skills is very important and must be owned by students as a concept development of the material being studied (Nurmantoro et al., 2022). Creative thinking skills are one of the 21st century learning competencies in the independent curriculum. It is expected that the creative thinking skills of teachers and students exist and become a basic need in implementing the concepts of the material being studied. Creative thinking skills are one of the key factors that are important in overcoming various complex problems in the industrial era 5.0 (Santoso & Wulandari, 2020; Widiatmaka, 2016; Yanti et al., 2020; Zainuddin et al., 2020).

The learning model applied by teachers, especially in biology subjects, the majority is still classified as conventional and teacher-centered (Siregar & Adlini, 2022). Conventional and teacher-centered learning models tend to cause boredom in learning, which is caused by passive student involvement in learning so that they are less motivated to learn sustainable (Hutasoit, 2021; Lestari et al., 2024). The application of conventional teacher-centered learning models has also not accommodated the creative thinking abilities of students (Fairazatunnisa et al., 2021). Therefore, it is necessary to apply a learning model that teaches students to think creatively and motivates students to implement material concepts obtained from learning activities.

Rusman (2009) states that connectivity in learning still needs to be optimally implemented. Connectivity is popular again in learning, one of which is through web learning (Riskiono & Pasha, 2020). Web learning has a weakness, namely that students cannot understand and master thoroughly when learning through web learning due to limited mastery of techniques in understanding it (Mu’arif et al., 2021). On the other hand, constraints in connectivity in the web-based learning process are the most significant thing (Firdaus et al., 2020; Mu’arif et al., 2021).

Learning without limits, one of which is through web learning, emphasizes learning that is centered on students (Rivalina & Siahaan, 2020). The advantage of web learning in learning is that it supports learners to optimize their learning experience and awareness of abstract and concrete experiences (Zahwa & Syafi’i, 2022). There are three challenges in designing seamless learning using mobile technology, namely: a) avoiding information overload, b) avoiding aspects that may cause the focus of the learner's attention to be distracted by the device, c) understanding the constraints in supporting naturally occurring learner collaboration on social context.

The infinite learning that has been applied in learning has weaknesses. Among the weaknesses is that the data obtained is sometimes less valid because the data analysis carried out is generally not specific. Seamless learning has been used as a medium in the learning model applied by teachers. So far, the connection of the material with other fields of study related to technology still needs to be improved. In addition to having an attractive display of learning materials, learning materials must also be made using certain learning approaches that are in accordance with the characteristics of the material (Rokhim et al., 2020). The weakness of implementation in teaching and learning activities (KBM) is only in the application of learning models based on technological developments in the era of society 5.0. In addition, borderless learning has not evaluated the achievement of students using connectivity - borderless learning (Ulfa, 2017).

According to Treffinger et al. (2010) the creative problem solving (CPS) model is one model that helps solve problems and manage change creatively. The CPS model has three main components: mastering the challenge; creating ideas; and planning the solution steps. The three interrelated components in CPS form a cycle. The CPS learning model allows students to solve the difficulties they face (Putri & Miharja, 2023). Students can also develop creative, rational, and logical thinking skills so that they are more courageous in expressing their opinions and creative ideas in the learning process which can build students' self-confidence (Khairani & Prodjosantoso, 2024; Wansaubun, 2020).

Based on the preliminary explanation, it can be seen that there is potential between creative roblem solving learning models, web-based learning and seamless learning to improve creative thinking skills in the field of biology. However, from existing research, there is no integration between creative problem solving learning models, web-based learning and seamless learning, especially in the field of biology. Therefore, this research aims to develop "Creative Interactive-Web and Seamless Learning Model (CRI-WES) to Improve Creative Thinking Ability and Cognitive Learning Outcomes of Biology Subjects of High School Students". The Creative Interactive-Web and Seamless Learning Model (CRI-WES) combines aspects of the Creative Problem Solving (CPS) model and the Connectivism model through web-based learning and seamless learning. Assessment of students' creative thinking skills using the CRI-WES learning model through aspects of fluency, flexibility, originality and elaboration, which are the minimum benchmarks for assessing creative thinking skills (Guilford, 1973), while the assessment of students' cognitive learning outcomes through assessment of tasks and tests.

Method

Development research is a type of research method that is often used to produce an intervention product. The results of this research are expected to address the needs and solve practical problems in the field of education (Plomp & Nieveen, 2014).

Wademan Model Development is *called the generic design research* model because the term generic refers to theory as a result of research that can describe intervention theory or design theory, namely knowledge generated from research. Clearly illustrate that approach and product (intervention) go hand in hand with approach and theory (design principles). The product prototype design process based on empirical data is necessary to obtain information about the quality of interventions and design principles. Its occurrence can make formative evaluation a critical feature and is placed in the context of educational design research based on the model developed by Wademan (Plomp & Nieveen, 2014).

This research develops model support tools to support the application of the CRI-WES model that has been developed. These supporting devices are in the form of Model Books, Textbooks, Student Worksheets (LKS), Research Instruments (IP), and Assessment Sheets (LP). Device validation includes content validity tests and construct validity tests, *small groups*, and *field tests* conducted by ahi and practitioners.

The design of the Wademan development model can be applied to the learning process in product development, such as models, learning strategies, learning methods, teaching modules and prototypes. Evaluation of the application of the CRI-WES learning model is carried out after the activity process ends. The purpose of this evaluation is to see whether the Learning Objectives (TP) have been achieved and whether all obstacles in the ongoing activities have been resolved.

This model has five stages in development, namely: problem identification, Identification of tentative products and design principles, tentative products and theories, prototyping and assessment of preliminary products and theories, and problem resolution and advancing theory. This Wademan development model design can be applied to product development's learning process, such as models, learning strategies, learning methods, teaching modules and prototypes. Evaluation of the application of the CRI-WES learning model is carried out after the activity process ends. The purpose of this evaluation is to see whether the Learning Objectives (TP) have been achieved and all obstacles in the ongoing activity process have been resolved.

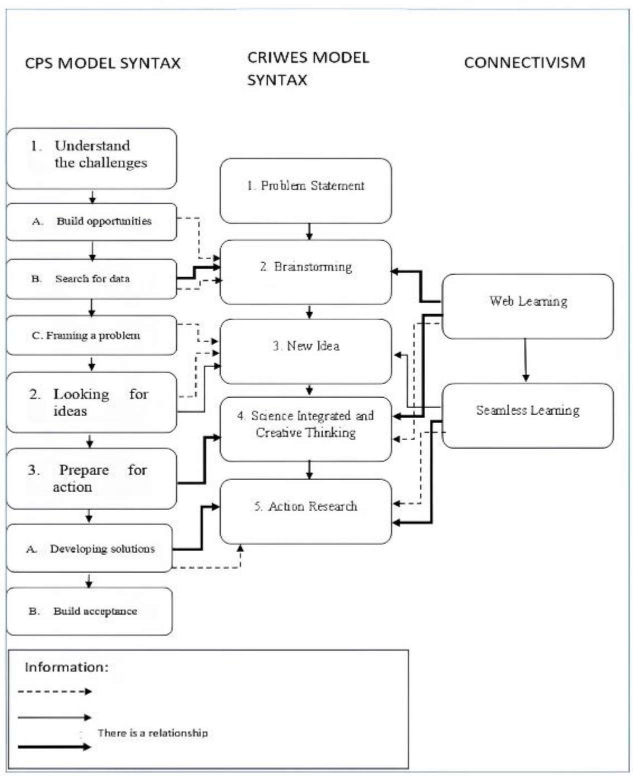

Figure 1. CRI-WES hypothetical model chart

Result and Discussion

The results of research and development of the CRI-WES model refer to the design of the Generic Design Research Model *(GDRM)* development research model, according to Wademan (Plomp & Nieveen, 2014) which consists of five stages of development steps, namely *p*roblem identification, *i*dentification of tentative products and design principles, *t*entative products and theories, *p*rototyping and assessment of preliminary products and theories, and *p*roblem resolution and Advancing theory.

The prototype design of the CRI-WES model is developed until the third stage, namely tentative products and theories, then the prototype is evaluated at the prototyping and assessment stage of preliminary products and theories and the final product is produced at the stage of problem resolution and advancing theory. The research and development results obtained from each stage of development are described as follows.

Step 1: Problem Identification

At this stage, a preliminary study is carried out to discover the problems that arise in schools, especially those related to learning activities, namely the applied learning model and studying problems related to the context, namely the development of learning models that produce creative thinking skills. The results of preliminary studies show that students' creative thinking skills are still low, so improving students' creative skills through learning activities is necessary. For this reason, a learning model has been developed that aims to be a guide in training creative thinking skills for high school students.

Step 2: Identification of Tentative Products and Design Principles

The second stage is to identify tentative product and design principles in the second stage of development research. The prototype of the hypothetical model is produced based on the results of theoretical studies and empirical evidence, where the appropriate model to train creative thinking is through a constructivism-based learning approach.

Some learning models based on constructivist approaches, such as creative problem solving (CPS) and learning by applying connective learning theory, are compelling enough to improve creative thinking skills but are too broad to apply if the application of connective theory as a whole (Lihu et al., 2021). In addition, the creative problem solving (CPS) learning model still needs to improve in terms of training attitudes, such as in the creative thinking skills of high school students. This study used these findings to develop a learning model with a design that follows technological developments (digitalization) but is also easy for teachers to apply in teaching students, namely the Creative-Interactive-Web and Seamless Learning (CRI-WES) model.

Step 3: Tentative Products and Theories

The hypothetical model of creative-interactive-web and seamless learning (CRI-WES) is created according to the product of a tentative learning model and the design principles of the conceptual framework according to the theoretical basis. Hypothetical creative-interactive-web and seamless learning (CRI-WES) model to improve creative thinking skills. The conceptual framework is further conceptualized as a CRI-WES model book.

The CRI-WES model book that has been developed consists of 4 parts of content, namely rationalization of the formation of learning models, the basis of model formation, the model description includes the model name, model development objectives, indicators of creative thinking skills, theoretical and empirical foundations of the model, learning activities: CRI-WES model syntax, mind mapping of the CRI-WES model. The model's components described contain syntax, social system, reaction principle, support system, instructional impact, and accompaniment impact. In line with research from Pada et al. (2018) regarding the virtual laboratory learning media that has been developed, which has the potential to support online practical learning, and macroscopic, submicroscopic and symbolic depictions in virtual laboratories can help the process of receiving information by students, shown by material validation results of 84% and media validation of 78%, which means it is valid for use during learning (Pada et al., 2018).

In addition, this study developed supporting tools for implementing the CRI-WES model, namely learning tools for the biology of environmental change materials, including global warnings, environmental damage and climate change. The material that has been selected has been adjusted to the characteristics of the CRI-WES model and the interactive media used in the learning process. The learning tools that have been developed are environmental change teaching module, student Worksheets (LKS) for four meetings consisting of causes and effects of environmental damage, causes of global warming impacts, climate change, and technology-based environmental conservation. Then there are also environmental change assessment for creative thinking skills includes grids, questions, answer keys and scoring guidelines.

Step 4: Prototyping and Assessment of Preliminary Products and Theories

Prototype 1 of the CRI-WES model is further validated and evaluated at *the* prototyping and assessment stage of preliminary products and theories. The fourth stage is the assessment stage of the product prototype developed in the previous stage. A series of formative evaluation assessments to produce the model's final prototype is also carried out at this stage. Evaluation is done through expert review activities (focus group discussion*),* content validation and constructs.

This research also developed a prototype as a *CRI-WES* learning model and model supporting learning tools to train students' creative thinking skills. Validation is done to validate the theory underlying the development and how the learning design is designed (Plomp & Nieveen, 2014). A prototype that has been developed is said to be of good quality if it has four criteria: relevance, consistency, practicality, and effectiveness (Nieveen & Folmer, 2013; Plomp & Nieveen, 2014). The validity of the content assesses the needs of the intervention model, and the *CRI-WES* model was designed based on the latest scientific developments. In contrast, construct validity (consistency*)* assesses how model interventions have been constructively and logically designed (Plomp & Nieveen, 2014).

The assessment stage by validators aims to test the validity of the content and construct of the model as well as the validity of the model-supporting devices (prototypes) that have been developed. The validation results will be used to conclude that the model intervention developed is valid and reliable. This validation phase results in a prototype used in limited trials.

Results of Focus Group Discussion (FGD) based on expert and practitioner review**, t**his CRI-WES model can be used to develop learning models and solve academic and non-academic problems related to creative thinking skills. This FGD 2 activity invited four practitioners after making improvements to prototype 1. Four practitioners are inspired and involved in teaching class X biology subjects from MAN 1 Kota Malang, MAN Kota Batu and MAN 2 Lamongan teachers. During the FGD, practitioners provided input on learning tools supporting the *CRI-WES* model.

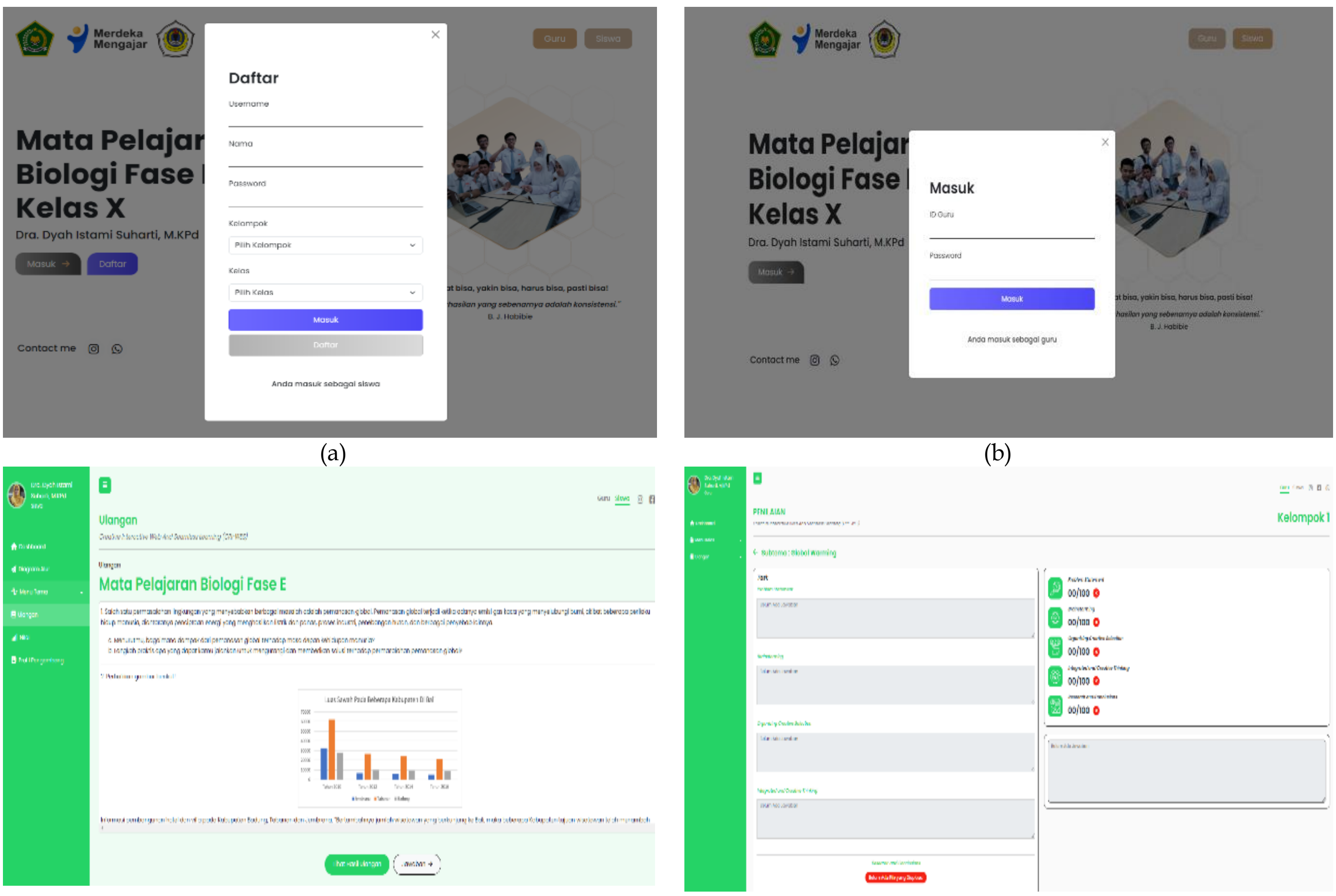

Figure 2. Display of web prototype: (a) Student login screen display; (b) Teacher login screen display; (c) Student test view; and (d) Teacher assessment menu display

Based on this input, improvements have been made to the learning tool. The result of the revision of Prototype 1 improvements is Prototype 2. In the results of this revision, the CRI-WES Learning Model is more colorful and lively. In research by Rokayah et al. (2021) regarding the development of social media Instagram, visualizing attractive images can provide benefits, namely increasing students' interest in stopping and viewing the page (Rokayah et al., 2021).

The validation results of two requirements for the development of good-quality learning models are relevance and consistency (Nieveen & Folmer, 2013; Plomp & Nieveen, 2014). The validity of learning models resulting from development research must meet aspects of relevance *and* consistency model validity testing includes testing the validity of content (criterion relevance) and construct validity (consistency) against the prototype of the learning model developed.

The CRI-WES model is tested by experts who test the validity of the contents and construct validity of the CRI-WES model after focus group discussion activities. The validity of the content of the CRI-WES model measures three aspects of assessment consisting of the need for the development of the CRI-WES model, the design of the CRI-WES model is based on the state of the art scientific knowledge; and a description of the CRI-WES model (Nieveen & Folmer, 2013; Plomp & Nieveen, 2014).

Table 1. Results of the CRI-WES Model Content Validity Assessment

Assessment aspect	Criterion	Reliability
The need for the development of the CRI-WES model	Yes	100 (Reliable)
The CRI-WES model is designed based on state of the art scientific knowledge	Yes	100 (Reliable)
Description of the development of the CRI-WES model	Yes	100 (Reliable)
Content validity		Highly valid
Percentage of agreement (PA)		100% (PA > 75%)

The results of this study show a reliability percentage of 100% (R>75%), so the CRI-WES model is very valid and has met the requirements of the relevance of model development, namely the need for model development, model design based on the novelty of scientific knowledge (state of the art scientific knowledge), and the existence of an explicit model description so that it can be implemented in learning (Nieveen & Folmer, 2013).

The construct validity model measures six aspects of assessment, referring to the assessment aspects of the construct validity (Nieveen & Folmer, 2013). The data analysis results obtained the assessment of the construct validity of the CRI-WES model, as presented in Table 2.

Table 2. Results of the CRI-WES Model Construct Validity Assessment

Assessment aspect	Criterion	Reliability
Rationality	Yes	100 (Reliable)
Theoretical and empirical support		100 (Reliable)
A.Phase 1. *Problem Statement*	Yes	100 (Reliable)
B.Phase 2. *Brainstorming*	Yes	100 (Reliable)
C. Phase 3. *Organizing creative selection*	Yes	100 (Reliable)
D.Phase 4. *Integrated and Creative Thing*	Yes	100 (Reliable)
E.Phase 5. *Research and Conclusion*	Yes	100 (Reliable)
Planning	Yes	100 (Reliable)
Implementation and components	Yes	100 (Reliable)
Learning environment	Yes	100 (Reliable)
Assessment and evaluation	Yes	100 (Reliable)
Construct validity		Very valid
Percentage of agreement (PA)		100% (PA > 75%)

The construct validity score of the CRI-WES learning model has very valid criteria and shows a reliability percentage of 100% (R>75%). The results of this validation study show that the developed CRI-WES model meets the requirements for model development consistency. Construct validity is the validity of the definition or validity which is understood as how far the impact of measurement results is able to reflect the theoretical constructs underlying the development of the instrument (Pada et al., 2018).

Based on the results of testing the validity of content (relevance) and construct validity (consistency) of the CRI-WES model, it can be concluded that the CRI-WES learning model is valid and reliable, PA ≥ 75% (Borich, 1994). The CRI-WES Learning Model has met the criteria of *relevancy* and *consistency* of model development. *The relevance criterion* is the main foundation in developing learning models; the model has been designed based on the needs and latest scientific developments. This research is in line with research from Rokhim et al. (2022) in the validation results for Instagram media as a learning platform obtained an average of 84.27% and were classified as suitable for use (Rokhim et al., 2022).

The CRI-WES model has been designed based on the need for the importance of increasing creative thinking through learning to prepare graduates to be ready to face challenges and changes that are so rapid in the era of the Industrial Revolution 4.0. The model was developed to overcome the problem, namely the students' low creative thinking skills obtained based on results from preliminary studies.

Supported tools for the validated CRI-WES learning model include ATP (syllabus), Teaching

Modules (RPP), Student Worksheets, Assessment Sheets (LP), observation sheets for learning implementation, student response questionnaire sheets, and student activity observation sheets. A summary of the validation results of the supporting tools of the CRI-WES learning model, which include ATP (syllabus), Teaching Modules (RPP), Student Worksheets (LKS), Teacher Interview Guidelines, Student Interview Guidelines, Observation Sheets of Teacher Activities in CRI-WES Learning, and Observation Sheets of Field Obstacles During CRI-WES Learning obtained from biology education experts are presented in Table 3.

Table 3. Summary of the Results of Biology Education Expert Validation of CRI-WES Learning Tools

Device type	Validation Score			Average	Category
	Expert 1	Expert 2	Expert 3		
Atp	4	3.56	3.56	3.70	Very valid
Teaching modules	3.42	3.64	3.78	3.61	Very valid
Student worksheets	3.5	3.65	3.7	3.62	Very valid
Teacher interview guidelines	Valid	Valid	Valid	Valid	Valid
Student interview guidelines	Quite valid	Valid	Valid	Valid	Valid
Observation sheet of teacher activities in CRI-WES learning	Quite valid	Quite valid	Valid	Quite valid	Quite valid
Observation sheet of field obstacles during CRI-WES learning	Quite valid	Valid	Valid	Valid	Valid

Based on validation from biology education experts, each learning tool is included in the very valid, valid and sufficient category to support learning with the CRI-WES model.

The results of assessments by experts and practitioners on supporting learning tools that have been developed are valid and reliable. All aspects can be categorized as very valid. The construct validity of the CRI-WES model learning device measures the consistency and logic of the supporting tools developed for the CRI-WES learning model. The devices tested for construct validity are ATP, Teaching Modules, LKS, and creative thinking skills assessment sheets. One of the aims of learning media is to increase students' learning motivation. Learning media can be in the form of audio-visual platforms, which can attract a lot of attention, especially among teenagers (Widarti et al., 2022).

A learning model must be adaptable and applicable (Joyce et al., 2009). Other learning support tools such as assessment sheets, Teaching Modules, and LKS are planned so that they can be carried out in the learning process efficiently and effectively. This finding shows that the supporting devices of the CRI-WES model that have been developed meet the *consistency* requirements of model development. The supporting tools of the CRI-WES model developed in the form of learning tools can be implemented in a learning activity following the Independent Curriculum.

The problem resolution phase involves identifying problems that may arise during the development of the CRI-WES model. Step 5 involves systematically solving problems, such as adjusting model parameters or updating datasets to improve performance. Meanwhile, advancing theory involves developing the theory behind the innovative learning model. Its implementation involves integrating new concepts or recent discoveries in learning theory into models, helping to push the boundaries of our knowledge of machine learning. All of this is iterative, with problem-solving and theory development complementing each other to enhance the effectiveness of innovative learning models.

Conclusion

Based on the discussion results, the developed CRI-WES Model and the model support devices are valid. The results of the biology education expert's validity analysis for content and construct validation showed a reliability percentage of 100% (R>75%). Biology education experts' validation of learning tools is included in the category of very valid, valid and sufficient to support learning with the CRI-WES model. Shows that the assessment tools and instruments are truly valid for use and do not require revision. This research produces an innovative learning model that is valid and can be used to assess practicality and effectiveness.

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Author Contributions

Conceptualization, D.I.S ;methodology, T.; validation, D.I.S and R; formal analysis, D.I.S.; investigation, D.I.S; data curation, D.I.S.; writing original draft preparation,D.I.S; writing review and editing,T and R; visualization, T and R. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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