What is Needed to Change Students' Waves Conceptions? Precursory Development of CoSiReT (Computer Simulation on Refutation Texts)

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Abstract. Before learning activities in class, some students have various conceptions, especially potential misconceptions. Therefore, this examination aims to develop Computer Simulation on Refutation Texts (CoSiReT) for wave learning. Updates on refutation text are useful to facilitate changing students' conceptions regarding the basic concept of transverse waves. The 3D model (Define, Design, and Develop) is used for the precursory research design. CoSiReT is designed to integrate computer simulation on Refutation Texts and is developed in interactive form. The research instrument consisted of validation sheets for five experts and six practitioners (physics teachers) in Tuban, East Java, Indonesia. The instrument consists of 15 indicators covering aspects of 1) instructions for use, 2) language, 3) presentation content, and 4) appearance. Expert and practitioner judgment data analysis using a rater test assisted by Mini-Facet Rasch software. The results stated that CoSiReT fulfilled all aspects and there were improvements to several indicators by the validator. Accordingly, the precursor development of CoSiReT can be sampled and implemented as a learning innovation that seeks to change students' conceptions of basic waves concept.

Keywords: Conceptual Change, Computer Simulation, Student Conception

Introduction

Conceptions that do not match the scientific understanding of experts are often called misconceptions [1-3]. Other names are alternative frameworks, intuitive beliefs, preconceptions, spontaneous critical thinking, children's science, and naïve beliefs [4,5]. The causes can be various, such as misunderstandings between students themselves, teachers, textbooks, teaching methods or learning media, and even everyday phenomena that are seen [5]. This potential misconception can surface before learning so it can evolve an obstacle to learning relevant concepts [6,7].

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In this regard, based on literature conducted by several researchers, several researchers have found misconceptions about transverse waves in students [8-12]. Research by [8], which was conducted in one of the East Java regional schools, stated that the results of a study related to the initial diagnostic assessment of 31% of 97 school students identified potential misconceptions about the basic concept of transverse waves during pre-learning. In existence, a sub-concept that is still frequently used is the relationship between variables in the basic concept of transverse waves [8-13]. In connection with this gap, students who have potential misconceptions must have their conceptions changed immediately.

Researchers have utilized various ways to change conceptions. One of them is that years of research show that refutation text is effective in changing conception [14,15]. However, in a literature review by [7, 16], it is recommended that refutation text can be accompanied by images, videos, etc. with the aim of not only containing text but also containing various forms of variations. This feature tends not to be boring. Therefore, the initial development of this learning media was carried out by integrating existing computer simulations into refutation texts, which are called computer simulations on refutation texts (CoSiReT). The precursory development of CoSiReT is illustrated in Fig. 1. Simulations help to display concepts that are abstract and difficult to understand [17,18]. So that the positive use of technology can support changing students' conceptions regarding the basic concept of transversal waves.

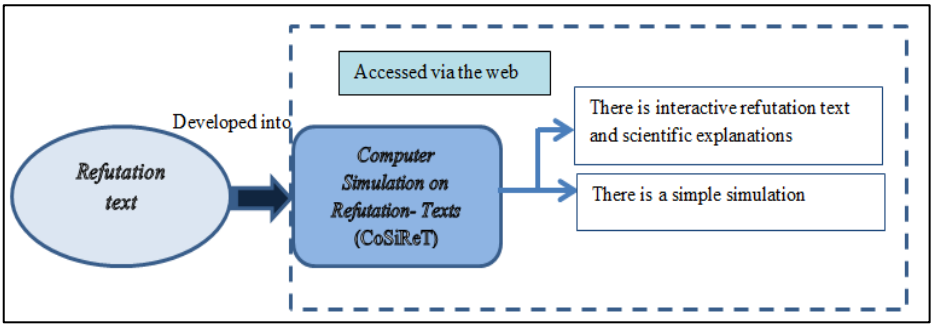

Fig. 1. Precursory development flow of CoSiReT

In sequence with this, this research aims to examine the precursory development of CoSiReT media which is used in changing students' conceptions of the basic concepts of transverse waves. The precursory development of CoSiReT was analyzed using Rasch analysis perception using mini-Facet software, which aims to analyze the results of assessments by validators in more profundity.

2 Method

2.1 Research Design

The 3D model (Define, Design, and Develop) is used for the precursory research design. The respective stages are explained in Fig. 2. The 3D design is adapted from the design 3D+1I (Defining, Designing, Developing, and Implementing) [19] because it has not been implemented, so only 3D designs are used [5, 20].

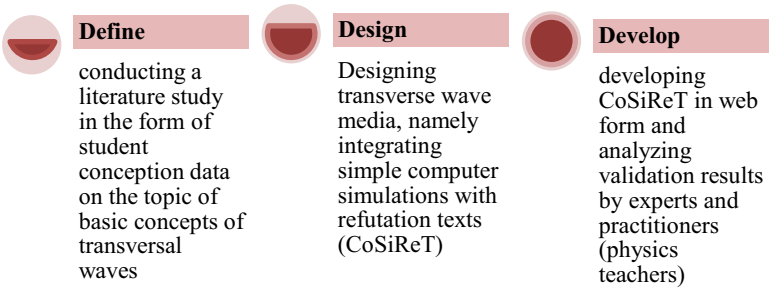

Fig. 2. CoSiReT's precursory research design uses a 3D design

2.2 Respondent

In this precursory research, the respondents of this research consisted of five experts (3 physics education experts and 2 media experts) and 6 practitioners of physics teachers (3 females and 3 males) in Tuban Regency, East Java, Indonesia.

2.3 Instrument

The instrument consists of 15 indicators covering aspects of 1) instructions for use consisting of 2 indicators, 2) language consisting of 2 indicators, 3) presentation content consisting of 7 indicators, and 4) appearance consisting of 4 indicators. Each indicator is assessed with the categories valid, valid with revision, and invalid. At the end of each aspect, open questions are presented, so that respondents can provide suggestions and opinions about CoSiReT.

2.4 Data analysis

Rasch analysis with the help of mini-Facets software was used to analyze respondents' statements. The results of the respondent's assessment were analyzed and described based on the results of the Wright map.

3 Results and Discussion

This section is explained based on the 3D Design stage (Define, Design, and Develop).

3.1 Define

This section is a literature study of the senior high school student's conception of the basic concept of transverse waves. This literature study is adjusted to the topics that students have received in school. Identify student conceptions using the MOFI-OTW diagnostic instrument from [8]. Based on the identification, students have potential misconceptions about the basic concept of transverse waves as shown in Table 1.

Table 1. Findings of students' misconceptions concerning the basic concept of transverse waves

Sub-concept of the Basic concept of Transverse Waves	Frequency of misconceptions (%)
Direction of propagation of transverse waves	29
Graph of the relationship between deviation with time and deviation with distance	34
The relationship between transverse wave variables, such as the relationship between amplitude, wavelength, wave propagation, frequency, and period	37

Based on the identification in Table 1, there are still many students who experience misconceptions or express alternative conceptions based on intuition or natural phenomena events in everyday life. Misconceptions still occur in situations that require visualization in learning. Consequently, an alternative solution to change students' conceptions is to integrate computer simulations into refutation texts so that CoSiReT is developed.

3.2 Design

This section designs the form of CoSiReT features and content. The development of CoSiReT is useful for changing the conception of high school students. The CoSiReT feature design includes disclaimer text integrated into simple computer simulations, while the physics content contains basic concepts of transverse waves. Apart from that, it includes changes to Posner's conception [21]. The CoSiReT design created is presented in Fig. 3.

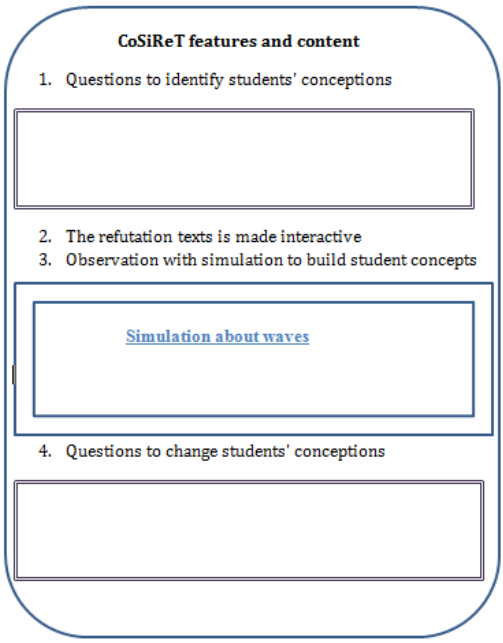

Fig. 3. CoSiReT design and steps

3.3 Develop

This section discusses the development of CoSiReT which is made in web form. Further, a validation analysis was carried out based on assessments from five experts and six physics teachers (three females and three males). The following are the results of the CoSiReT assessment using mini-Facets Rasch which are presented in Fig. 4. In Fig. 4, the right part is a validator consisting of five experts coded with V1, V2, V3, V4, and V5, while the validator consisting of six physics teachers is coded with P1, P2, P3, P4, P5, and P6. In the middle is an assessment indicator coded with certain words, for which a detailed explanation is included in Table 2.

Table 2. CoSiReT assessment indicators

Aspects	Indicators	Code
Instructions for use	Instructions for the media are clearly	Instruction
	Learning objectives are clearly	Objective
Language	Following the rules of Indonesian	Rule
	Conformity with the intellectual and psychological development	Intellectual
Content	The completeness and depth of the transverse wave concept	Complete
	The use of simulations to build student concepts	Simulation

Aspects	Indicators	Code
	Simulations are useful for making virtual observations	Virtual
	Cosiret can change conceptions through scientific explanations	Scientific
	The process of cognitive learning (oriented towards the construction of students' knowledge)	Cognitive
	Coherent and systematic activities	Systematic
	The relevance between the concepts of transverse waves includes four conditions for changing the concept	Concept
Appearance	Cosiret having an attractive appearance and motivating to learn	Interesting
	Cosiret being easy for users to use	Easy
	Cosiret being flexible which can be used via laptops and smartphones	Flexible
	Cosiret is interactive to refute misconceptions students are directly	Interactive

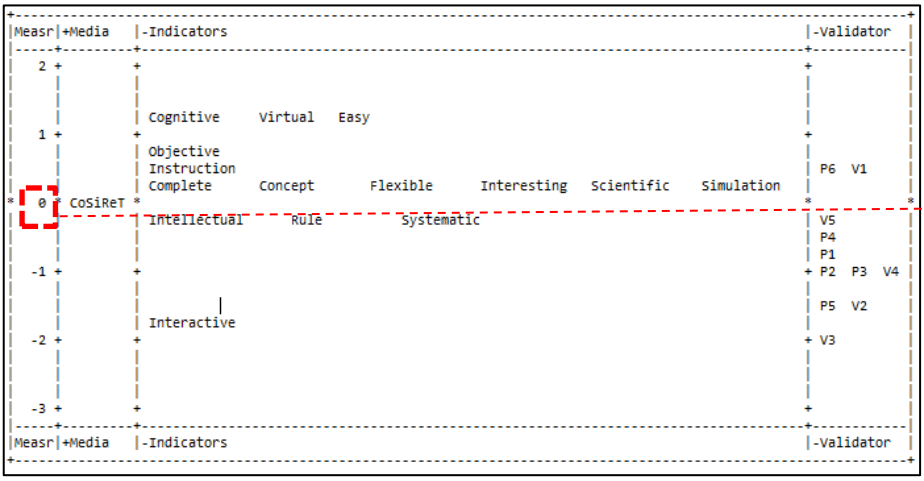

Fig. 4. Results of expert judgment analysis using Mini-Facets Rasch reviewed from Wright-map

Based on the results of the Wright map illustration in Fig. 4, there is a logit scale limit of 0. A scale above logit 0 indicates a positive scale value. It indicates that what is being measured is valid. Meanwhile, a scale below logit 0 indicates a negative scale. This means that what was measured is invalid or requires revision. Each assessment indicator is coded with a specific word. In the Media column, CoSiReT is above the logit scale limit of 0 so the results are valid. Nevertheless, the indicators "Intellectual", "Rule", "Systematic", and "Interactive" are below the logit scale of 0, so CoSiReT needs to be improved regarding these indicators.

In the "Intellectual" indicator, practitioners suggest improving it according to students' intellectual and psychological development. In the “Rule” indicator, improvements are made to the structure and spelling of sentences as well as language rules. In the “Systematic” indicator, experts recommend checking CoSiReT activities

again so that they are more coherent and systematic. In the "Interactive" indicator, experts and practitioners suggest adding further interactive features, namely adding an interactive level of confidence after the question. The level of confidence is the most complete diagnosis so that it can detect students' conceptions in detail. The results of improvements after revisions displayed via the web are shown in Fig. 5.

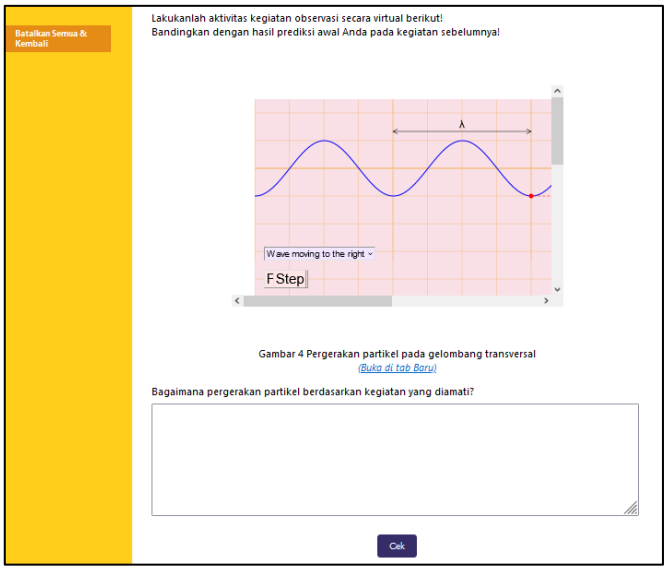

Fig. 5. The example result of CoSiReT

Based on the revision results of the content and appearance of CoSiReT in Fig. 5, CoSiReT was revised by adjusting intellectual, psychological, and language development at the high school level, which is a level that is not overly high for students. In addition, a confidence level is added for each conception question in CoSiReT content. Thus, the revision results of these four indicators make CoSiReT more appropriate for use. Overall, CoSiReT satisfies 15 assessment indicators according to experts and practitioners (physics teachers). As a development, CoSiReT can be implemented to change students' conceptions of the basic concepts of transverse waves.

4 Conclusion

The research results show that CoSiReT is valid and has been revised according to expert suggestion. This means that the integration of computer simulations on refutation texts (CoSiReT) can be used to innovate wave learning, especially to change conceptions. Based on the results of the Wright-maps analysis assisted by Mini-Facets Rasch software, expert and praticioners (physics teachers) remarked that CoSiReT satisfied 11 assessment indicators. The experts suggest that there are slight improvements

to the three assessment indicators coded "Rule", "Systematic", and "Interactive", while the assessment based on practitioners (physics teachers) provides suggestions for revising the two assessment indicators coded "Intellectual" and "Interactive". The advancements made refer to the role of CoSiReT, namely that CoSiReT can function to change students' conceptions. These results will then be used as a basis for the further development of CoSiReT, namely the implementation of CoSiReT in changing students' conceptions of the basic concepts of transverse waves.

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