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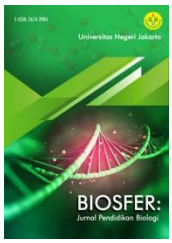

Development of visual learning style-based learning model biology subject

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ABSTRACT

This study aims to develop a learning model that is valid and practical and suits the visual learning styles of students in biology subjects. This research is expected to improve student learning outcomes through technology that is more interactive and interesting. This research uses a development research method based on the Plomp model, which consists of four phases, namely initial investigation, design, realization, evaluation, and revision. The research subjects were grade X students at one of the schools in Mataram city. The instruments used include expert validation questionnaires and user practicality assessments analyzed using a Likert scale of 1-4. The data obtained were then analyzed descriptively. The learning model developed includes four stages, namely screening, visualization, elaboration, and reflection abbreviated as SrVER. The results showed that based on the validity test by validators, the learning model based on visual learning styles with the help of AR obtained an average percentage of 88.2% in the valid category. Based on the teacher's response, a rate of 95% was obtained with a very feasible category, and based on student responses, a percentage of 81.78% was obtained with a very feasible category. Using the SrVER model with the help of AR media in this model makes learning more interesting and helps students understand the material better.

INTRODUCTION

Learning styles or modalities are ways of easily receiving, processing, remembering, and applying information (Widaysanti, 2013). Each learner has a different learning style, which affect how information is received, processed, and remembered. The information absorption process by individuals/students varies in speed: fast, moderate, and slow. Therefore, learners often need different approaches to receive and retain information in the long term effectively.

There are three kinds of learning styles: visual, auditorial, and kinesthetic, popularly called VAK (Wiedarti, 2018). Visual learning is a learning style by seeing so the eyes play an important role. Auditory learning is a learning style by listening so the ears play an important role. The kinesthetic learning style is a way of teaching a person to obtain information by doing experience, movement, and touch (Irawati et al., 2021). Every student needs to recognize their learning style to make it easier for them to learn.

The results of a preliminary study conducted on students in several junior high schools and high school students in Mataram, Indonesia show that most students tend to have visual learning styles and audiovisual learning styles. Visual learning style is one of the learning styles that affect student learning achievement. Research conducted by Bire et al. (2014) shows that visual learning style influences 66.55% of student learning achievement variables. The results also show that visual learning style has a positive relationship with achievement of 0.127, meaning that the higher the use of visual learning style, the higher the student's learning achievement.

Mufidah (2017) explains that recognizing learning styles can determine more effective learning methods. Learning styles can help students absorb knowledge easily. The easier students grasp the material, the better the learning outcomes. Knowledge of students' learning styles will also make it easier for teachers to create fun learning and motivate students to learn (Daik et al., 2020), and help improve student achievement through the application of appropriate learning methods and models (Abdurrahman & Kibtiyah, 2021).

The learning model encompasses the entire sequence of learning depicted from the beginning to the end of the instructional process, uniquely presented by teachers to achieve learning objectives (Idayanti et al., 2023; Rifa'i et al., 2022). The approach to education has significantly shifted from teacher-centered models to student-centered ones. This change is crucial in preparing students to face future challenges filled with 21st-century skills (Hasanah & Haryadi, 2022; Mulia et al., 2020). Learning models that emphasize the role of students in the learning process provide opportunities for students to actively engage in managing their learning. This encourages deeper involvement and allows for more personalized and relevant learning. Such an environment fosters creativity, collaboration, initiative, and independence. Research findings by Suhariami et al. (2019) also indicate that students should be able to optimize their learning independently by combining cognitive and emotional abilities. This approach not only enables students to be at the center of learning but also facilitates better understanding by presenting information in a structured and comprehensive manner.

According to Asyafah (2019), there are several important reasons related to the development of learning models: a) effective learning models greatly assist the learning process so that goals are achieved, b) they can provide useful information for students in learning, c) variations in learning models can enhance students' learning motivation. Students also need to recognize their learning styles so that they can manage learning under what conditions, where, when, and how good and effective learning methods are. Furthermore, Sutiah (2018) also explains that the appropriate learning model can have an impact on students' domination in learning, such as being creative, active, and innovative, and creating a pleasant atmosphere that will positively impact learning outcomes.

Although various learning models have been developed, the application of learning models that specifically accommodate students' visual learning styles has not been optimal in practice. Most of the learning models applied in schools emphasize more on students' skill mastery activities, such as finding solutions and solving problems (Meilasari et al., 2020), teamwork skills (Sappaile et al., 2023), the ability to form knowledge based on previous experience (Syamsidah et al., 2023), and mastery of 21st-century skills. The learning models used generally focus more on facilitating students to acquire skills rather than accommodating students' learning styles. Based on the above problems, research on the development of visual learning style-based learning models needs to be done. The purpose of developing this learning style-based learning model is to have a positive impact on student learning outcomes.

METHODS

Research Design

This research is a development research design concerning Plomp's (2010) research that consists of 4 stages, including 1) preliminary investigation, 2) design, 3) realization/construction, 4) test, evaluation, and revision, which are simplified into 3 stages, namely problem identification, media and model development and limited testing of products. The research method used is descriptive, where the research method tries to describe research activities carried out on certain objects clearly and systematically (Jayanti & Jamil, 2016). The development research will then produce valid and practical learning models and media.

Population and Samples

The population in this study were all class X students at SMA Negeri 2 Mataram, Indonesia, totaling thirteen classes. The research sample used was one class totaling 35 students. Sampling was done using the purposive sampling technique.

Instrument

The instrument used in this research is a questionnaire to assess the validity and practicality of the learning model used. Validation was carried out by two lecturers as learning model experts. Validation is carried out to obtain suggestions and input on the product developed so that it is feasible and valid to use (Rizanti et al., 2023). The questionnaire instrument consists of 13 questions related to the practicality of the model, the suitability of the model to the flow of learning objectives, the suitability of the model to the needs and competencies of teachers and students, the suitability of the model with supporting media, and the ability of the model to make learning interactive, reflective, and fun. The feasibility assessment of the learning model was carried out using a questionnaire instrument given to the teacher consisting of 15 questions and a student questionnaire consisting of 5 aspects. The assessment of the questionnaire instrument is carried out using a Likert scale with four alternative answers, namely scale 1 for very unsuitable, scale 2 unsuitable, scale 3 suitable, and scale 4 for very suitable adapted from (Ratih, 2022). The Likert scale is used to measure the attitudes, opinions, and perceptions of a person or group of people about social phenomena.

Procedure

This research was conducted in four phases: (1) preliminary investigation phase, which was carried out by conducting a literature review on learning theory and practice and the factors influencing it. In this phase, discussions were also held by several teachers to gather information about the problems faced by teachers during the learning process. (2) Design phase involves the development of a learning model framework that is suitable for the problems identified in the preliminary investigation phase. (3) The realization/construction phase involves developing the learning model based on the framework designed in the previous phase. In this phase, the learning model and its syntax are obtained. (4) Test, evaluation, and revision phase involves validation activities by expert validators and product trials in a limited class. The results obtained are then revised according to the directions and suggestions from the validators.

Data Analysis Techniques

Validation data by validators and limited trial data by teachers and students were used as data on the validity and feasibility of the learning model. The data obtained were calculated using the percentage formula and categorized based on the criteria adopted, Handayani et al. (2020) presented in Table 1. The data were then analyzed descriptively and qualitatively.

Table 1.
Criteria for Learning Model Feasibility

Feasibility Achievement Criteria	Feasibility Level
81.00% - 100.00%	Highly Feasible/Practical
61.00% - 80.00%	Feasible/Practical
41.00% - 60.00%	Fairly Feasible/Practical
21.00% - 40.00%	Less Feasible/Practical
00.00% - 20.00%	Not Feasible/Practical

RESULTS AND DISCUSSION

Initial Investigation Phase

Based on direct observation activities, interviews, and cognitive learning test results, the following information was obtained: (a) 65% of teachers use discussion or lecture methods during classroom learning, while the remaining 35% occasionally use experiments, cooperative learning, modeling, and PBL; (b) the learning media used by teachers are still in the form of videos, and PPT has never used Augmented Reality media and other interactive media such as mentimeter.com, some teachers use Quizizz media; (c) teachers have never conducted learning style tests on students, so they do not know the tendency of their student's learning styles.

Based on the results obtained from the initial investigation, it was found that most of the learning process is more teacher-centered rather than student-centered. Teachers often use lecture and discussion methods. However, there is a connection between the learning strategies used and the learning outcomes. An ineffective learning process will be followed by suboptimal learning outcomes. This connection is reinforced by Agustin et al. (2020), who explain that learning strategies influence the achievement of learning outcomes. Hermanto et al. (2023) explain that students' conceptual understanding and learning retention are affected by learning strategies. Similarly, Pranoto (2016) states that the better the learning strategies implemented, the higher the students' academic performance. Therefore, teachers must continually strive to improve their understanding of learning models, strategies, and methods to achieve better learning outcomes.

Technological advancements demand that teachers master updated learning media, both interactive media, and media that clarify concepts. Based on the initial investigation results, the media commonly used by teachers are instructional videos and PPT. However, media selection should be based on identifying students' needs and preferences. According to Dewantara et al. (2020), the media used should be appropriate and targeted, aligned with students' needs, and in tune with technological developments. Furthermore, Miftah & Nur Rokhman (2022) explain that a teacher's ability to choose media that aligns with the learning objectives is crucial, as inappropriate media selection can reduce students' comprehension of the subject matter.

Classes consist of students with various learning styles, and ideally, each student's learning style should be accommodated and facilitated based on their preferences. The use of interactive media such as Mentimeter and AR has not been widely adopted by science teachers in Mataram. Therefore, these media deserve to be tried. However, the media require a suitable learning model because media serve only as tools to clarify messages, not to structure the learning process.

Design Phase

In this phase, a learning syntax was designed by examining the results of learning needs in the field and analyzing theoretical studies that underlie the importance of developing a learning model. The designed learning model is named the SrVER model. The SrVER learning model emphasizes visual learning styles, whereas visual learning styles emphasize students' ability to see. SrVER is an acronym for Screening, Visualization, Elaboration, and Reflection, where each stage has its meanings and objectives as presented in Table 2.

Table 2.
Description of SrVER Learning Model Activity Stages

Stage Activity	Meaning
Screening	Exploration activities or diagnostic activities aimed at identifying students' prior knowledge related to the material, providing appropriate learning doses so that there is no gap between prior knowledge and new knowledge provided.
Visualization	Activities to display visuals of images to make them clearer for students with the aim of reinforcing understanding of concepts from student readings or teacher explanations so that they appear more real.
Elaboration	Collaborative activities among students in solving problems in worksheets or assignment sheets with the aim of training students' communication and collaboration skills.
Reflection	Students reflect on their learning or measure their learning abilities with the

Stage Activity	Meaning
	aim of training students' reflective abilities so that they realize what they have learned and what they want to learn.

To support the implementation of the SrVER model, several preparations are needed: (1) teachers need interactive media such as PPT or instructional videos, (2) teachers use interactive media mentimeter.com to conduct screening and reflection activities, (3) download the Assemblr Edu application by both students and teachers to use Augmented Reality (AR) media, (4) provide students with worksheets or assignment sheets for students to collaborate on solving problems related to the material, (5) ensure technology accessibility for all students equally to the devices needed to participate in learning smoothly.

Realization/Construction Phase

In this phase, the syntax of the SrVER learning model is produced. The SrVER model consists of four syntaxes: screening, visualization, elaboration, and reflection, as explained in Table 3.

Table 3.
SrVER Learning Model Syntax

Learning Syntax	Activities
Screening	The teacher explores students' prior knowledge by asking questions related to the material to be learned using interactive media (mentimeter.com).
Visualization	The teacher presents the material in an overview using PPT or instructional videos, clarified with 3D images in augmented reality media
Elaboration	Students collaborate with group members to discuss student worksheets related to the provided material.
Reflection	Students create self-reflections by visualizing them in the form of mind maps or words/sentences written using media (mentimeter.com).

Many learning models have been claimed or proven to make learning more meaningful (Darmayanti et al., 2020; Habib et al., 2020; Muliandari, 2019; Wirta, 2021). However, a learning model needs to be developed based on students' learning style tendencies, including visual learning styles. Therefore, a learning model based on visual learning styles with the aid of interactive media and Augmented Reality is developed.

Multimedia learning media in the form of interactive videos can increase students' interest and motivation, involving them actively (Wardani & Syofyan, 2018). Interactive means two-way communication (Yuniarni et al., 2020). Media is considered interactive when there is engagement between the learners and the media, so the learners are not merely watching or listening to the content within the media (Yasa et al., 2017). Instead, the learners are allowed to respond and engage in various activities (Biassari et al., 2021). One important component of interactive videos is the use of computers or similar devices.

Through the SrVER model syntax, it is evident that the learning process begins with screening, which provides an overview of students' abilities. Prior knowledge (PK) is a crucial step in the learning process; thus, teachers need to understand the level of PK students possess. PK influences students' learning experiences significantly (Astuti, 2015). Knowing students' PK helps teachers determine if they have the prerequisite knowledge to follow the lesson and how much they already know about the upcoming material (Razak, 2017). Consequently, teachers can design lessons more effectively (Aliyah, 2019). Studies also show a significant correlation between students' initial abilities and their academic performance (Astuti, 2015; Herviansyah & Megawanti, 2016).

The visualization activity emphasizes the eyes' ability to see visual media, as the eyes are the first sensory organ to record stimuli before the brain interprets them. Therefore, enhancing visual clarity through auxiliary media is crucial. As Ghraibeh & Al-Zahrani, (2013) explain, the eyes as visual fields are controlled in a complex manner, transferring information to both brain hemispheres. This visual activity helps students better understand the material presented. According to Dwiyogo (2014), visual media make it easier for students to improve their memory of the material.

Elaboration activities give students opportunities to develop ideas, thoughts, and creativity in expressing cognitive concepts in various ways, whether orally or in writing, fostering confidence in their abilities (Nusyam, 2009). Elaboration can be done through group discussions, exhibitions, reports,

products, presentations, competitions, library research, internet browsing, and other cognitively and creatively challenging activities. This aligns with (Widyantari et al., 2019) who state that elaboration involves complex thinking activities such as note-taking, summarizing lessons, and making analogies. Note-taking, though not central, is crucial as it enhances memory (Dewi & Indrawati, 2014). Summarizing trains students to grasp core concepts and create connections between concepts, making the information more meaningful (Widyantari et al., 2019). Analogies help students understand concepts by bridging known and new knowledge (Justica et al., 2015).

The final stage of the SrVER model is reflection. Reflection is vital for both students and teachers as it ensures effective teaching and learning (Afroni et al., 2022). Reflective learning involves reviewing teaching actions and linking past lessons with future ones, considering their impact on the learning process and outcomes (Julaeha, 2009). Reflection involves introspection, critical and analytical thinking, and consideration of various aspects of the learning process. Reflective practice helps students learn from experiences, understand their learning preferences, and think critically about their learning (Klimova, 2014).

Evaluation and Revision Phase

In this phase, the syntax is validated by expert validators. There are two validators to assess the feasibility of the developed learning model. The validation results are presented in Table 4.

Table 4.
Recapitulation of Expert Validator Results on the SrVER Learning Model

Aspect	Validator Assessment Results		
	1	2	Average
The Practicality of the model	91.00%	83.00%	87.00%
Alignment of the model with Learning Objectives	100.00%	75.00%	87.50%
Alignment of the model with current teacher and student competency needs	100.00%	100.00%	100.00%
Compatibility of the model with supporting media	100.00%	81.00%	79.00%
The model's ability to make learning interactive, reflective, and enjoyable	90.00%	85.00%	87.50%
Average		**88.20%**	

Based on the analysis of the validation sheets by the two validators, an average score of 88.2% was obtained. The next step is to revise Prototype 1 based on suggestions and feedback from the validators. The validators suggested, "In the visualization phase, do not rely solely on the use of PPT but also consider using other media such as instructional videos or other media emphasizing visual images." Subsequently, the syntax was revised to allow teachers the freedom to use auxiliary media like PPT or videos during the visualization phase. The revised syntax is referred to as prototype II. Prototype II was then tested on the learning model syntax for the excretory system material. The trial results in a limited class consisting of biology teachers and 10 students at SMAN 2 Mataram are presented in Table 5.

Based on validation by experts, the SrVER model is considered highly valid and practical for use in learning. This is evident from the various measured aspects that scored above 80, including model practicality, alignment with teacher and student competency needs, compatibility with supporting media, and the ability to make learning interactive, reflective, and enjoyable. The SrVER model is easy for teachers and students to implement, aligning with Nieveen (1999) that practical learning tools are easy to use and implement. The SrVER model meets teacher and student competency needs by incorporating technology to facilitate learning. Technology mastery is essential for both teachers and students in the 21st century and the 4.0 revolution era (Elitasari, 2022). Technology aids in material delivery and makes learning more engaging and enjoyable (Edriati et al., 2021).

Table 5.
Recapitulation of Teacher Responses as Users of the SrVER Model

No	Indicator	Score
1	Alignment of time with the learning process	4.00
2	The model's ability to achieve learning indicators	4.00
3	Effectiveness of utilizing learning resources by students using the developed model	3.00
4	Alignment between the steps in the learning model and its implementation in the	4.00

No	Indicator	Score
	classroom	
5	The model's ability to develop positive habits in students during the learning process	4.00
6	Alignment between learning activities and learning objective	3.00
7	The model's ability to make students active in the learning process	4.00
8	The model's ability to make students creative in the learning process	4.00
9	The model's ability to involve students in collaboration	4.00
10	The model's ability to explore students' knowledge	4.00
11	The model's ability to create meaningful learning for students' lives	4.00
12	The model's ability to provide understanding and a lasting impression on students	4.00
13	The model's ability to create an enjoyable learning atmosphere	4.00
14	The model's alignment with media and learning outcomes	3.00
15	The model's ability to create an enjoyable learning atmosphere	4.00
	Total	57.00
	Percentage	95.00%

Based on teachers' responses to the use of the learning model, a percentage result of 95% was obtained. This result indicates that the SrVER learning model is very feasible or very practical. The student responses to the implementation of the SrVER model are presented in Table 6.

Table 6.
Recapitulation of Student Responses to the Implementation of the SrVER Model

No	Indicator	Percentage (%)
1	The model's ability to create enjoyable learning	81
2	The model's ability to build student learning independence	76
3	The model's ability to generate student interest in learning	87.5
4	The model's ability to build student learning motivation	80
5	The suitability of media usage in the learning model	84.2
	Average percentage	81.78

Based on student responses to the use of the learning model, an average percentage of 81.78% was obtained. This result indicates that the SrVER learning model is very feasible or very practical.

Teacher and student responses also indicate that the SrVER model is highly feasible and practical. According to Fatmawati (2016), practical learning tools support conducive learning and expected outcomes. Teachers stated that the SrVER model makes students active, creative, collaborative and provides meaningful learning experiences. Creative and collaborative thinking skills are essential in the 21st century (Angga et al., 2022; Malikah & Wafroturrohmah, 2022; Mardhiyah et al., 2021). The 21st-century demands require teachers to be creative and innovative in applying learning models that construct students' knowledge, combining models and technology to foster student creativity and innovation (Rosnaeni, 2021). Therefore, the SrVER model is suitable for training students' 21st-century skills. Additionally, teachers stated that the SrVER model provides understanding and a lasting impression on students and creates a pleasant atmosphere.

Student responses indicate that the learning model makes them interested, motivated, and independent in learning, making the process enjoyable. According to Rasam & Sari (2018), if students are interested in the learning material and it is presented engagingly, learning activities are more likely to succeed. Studies also show a significant impact of learning motivation on students' outcomes (Novianti et al., 2020; Wijaya, 2018). Similarly, learning independence positively affects students' academic performance (Bungsu et al., 2019; N. Handayani & Hidayat, 2019; Indah & Farida, 2021; Wiriani, 2021). Independent learning leads to long-lasting conceptual understanding and better academic achievement. This shows that learning models contribute to students' abilities. Siang et al. (2020) explained that the choice of learning model or method is a factor affecting students' learning outcomes.

The engaging and enjoyable learning process using the SrVER model is not just due to its steps but also because of the Augmented Reality media. The advantage of AR is its attractive display, allowing students to see 3D objects as if they were real, with an interactive aspect (Faiza et al., 2022). Studies also show that students find AR media very enjoyable and helpful for understanding the material (Pringgar & Sujatmiko, 2020). Augmented reality (AR) media is fascinating for students as it allows them to see

objects in their real forms, albeit virtually (Carolina, 2022). Thus, AR can be a compelling technological choice for the learning process (Zaid et al., 2022).

CONCLUSION

Based on the analysis and discussion results, the learning model based on learning styles assisted by augmented reality media was categorized as valid according to the validators' assessment and was deemed very feasible or highly practical for use in the learning process. The results of this study can be used as an alternative learning model for biology subjects in schools to improve student learning outcomes. This study's findings can also serve as a basis for developing learning models that utilize technology. This learning model was implemented in only one school in Mataram, Indonesia. The development of the SrVER learning model based on learning styles assisted by augmented reality media can be directed toward testing its effectiveness to optimize its use.

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