REACT Strategy: Efforts to Link Concept Colligative Properties Application in Daily Life and Science Development

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Abstract. Applying the concept of colligative properties of solutions is closely related to everyday life and science development, so the REACT strategy can be applied in learning. This research aims to develop a valid flipbook for learning the colligative properties of solutions that relate the concepts and their applications in everyday life with the ADDIE development model (Analyse, Design, Develop, Implement and Evaluate). The results obtained from content validity and face validity concluded that the flipbook developed was valid in terms of clarity and ease of understanding text, video, and images for each section of the relating, experience, and applying stages following the conceptions of experts and the topics discussed and presented different problems, from context and new in addition to the examples of questions and exercises discussed in the relating, experience and applying sections. Student responses after being taught with the developed flipbook indicate that the developed flipbook is very easy to use on various computers or laptops, helps students explore information about concepts and their applications, helps help with assignments, serves as an additional reference, adds insight into the relevance of concepts in everyday life.

Keywords: concept colligative properties · REACT strategy · application · daily life · science development

1 Introduction

The development of time requires a paradigm shift in chemistry education. Chemistry learning, which used to focus on studying concepts in the classroom, has shifted towards applying concepts to solve real-life or contextual problems [1]. Presenting real-world problems can encourage the interconnection of the learned concepts, develop complex thinking skills, and build literacy in selecting relevant concepts or information related to the given problems [2]. In other words, providing real-world problems in chemistry education teaches hard skills (conceptual understanding and laboratory work), develops critical thinking skills and problem-solving abilities, and fosters creativity in addressing real-life problems [3, 4].

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Colligative properties of solutions are one of the chemical concepts with broad applications in solving everyday life problems. For example, the use of the concept of reverse osmosis to address the scarcity of freshwater in coastal areas [5]. Another example is using a mixture of ethylene glycol and water as a coolant for vehicles in tropical regions, utilizing the concept of boiling point elevation or freezing point depression [6]. Apply the colligative properties of solutions in everyday life, and several prerequisite concepts need to be understood, such as solution concentration, boiling point, freezing point, and osmosis phenomena [7].

Applying colligative properties of solutions in solving everyday problems requires students to make assumptions, analyse and evaluate arguments, and assess or make generalizations and conclusions based on relevant information or data [8, 9]. Solving real-world problems without the thinking process only leads to invalid results, numerous shortcomings, and, even worse, cannot be considered as outcomes or solutions to the problems at hand [10, 11]. Therefore, it is necessary to consider an instructional approach to colligative properties that considers the concept's characteristics. Should be done to ensure that prospective chemistry teachers acquire a comprehensive understanding of colligative properties and to produce professional teachers. A professional teacher possesses a deep understanding of the scientific concepts in their field of study, also known as Chemistry Content Knowledge.

Teaching strategies and instructional materials that support the learning of colligative properties of solutions and their application in everyday life need to be considered. The REACT strategy, based on a contextual-based approach, involves students facing real-life situations, engaging in discovery or exploration activities directly related to their daily lives, applying concepts and information in meaningful ways to solve real-world problems they encounter, and sharing their findings with peers or the community through discussion activities [12].

The REACT strategy consists of five stages: relating, experiencing, applying, cooperating, and transferring. In the relating stage, learning occurs through real-life contexts (experiences, events, or everyday conditions) and establishes connections between the context and the information to be used. In the experiencing stage, students engage in exploratory or discovery activities that allow them to acquire new information related to the context or problem to be solved. The applying stage involves implementing new concepts or information in real-life contexts and projecting their utility in future scenarios or unfamiliar locations. In the cooperating stage, students present their achievements to others, respond to the accomplishments of their peers in a collaborative learning context, and engage in reflection activities based on the outcomes achieved. The transferring stage involves using or building upon the knowledge gained in new and unfamiliar contexts or problems.

This research aims to develop instructional materials in the form of a flipbook on the concept of colligative properties of solutions using the REACT strategy. The developed flipbook presents real-life situations or conditions related to the concept of colligative properties of solutions. It provides a description of the material or concepts of colligative properties of solutions, accompanied by instructional videos that help students understand the content of the reading material. After learning the concept, the flipbook provides a review of the application of the concept in solving everyday problems and its significance in scientific advancements. Towards the end of the instructional materials, students are presented with new problems or different contexts and must solve them using the concepts they have learned.

2 Materials and Methods

This study aims to produce a REACT-based flipbook on the colligative properties of solutions. Therefore, the research design used is Research and Development (R&D), which follows the ADDIE development model, which consists of five stages: analyse, design, develop, implement, and evaluate (Branch, 2009).

2.1 The Analysis Stage

The analysis stage in this research aims to explore the potential barriers and challenges students face in learning the concept of colligative properties of solutions, both in the classroom and through self-study. The subjects involved in this stage are ten second-year students of the Chemistry Education study program at FKIP Untan. The selection criteria for the subjects are based on their completion of the colligative properties of solutions course in their first year of study. The data collection instrument in the analyse stage is a student interview guide. Subsequently, the obtained interview results are qualitatively described in terms of the potentials, barriers, or challenges experienced by students in solving contextual problems related to the colligative properties of solutions.

2.2 The Design Stage

The design stage in this research involves designing instructional materials on colligative properties of solutions based on the REACT approach. In this stage, content boundaries are set, literature is collected, instructional videos are gathered, and new problems or problems in different contexts related to the concept of colligative properties of solutions are compiled. Subsequently, the design outcomes are organized into a storyline format.

2.3 The Develop Stage

The develop stage in this research involves composing a draft of a flipbook instructional material on colligative properties of solutions based on the REACT approach, following the created storyline. Subsequently, the draft is validated to assess its suitability for use. This study uses two types of validation: content validity and face validity. Content validity measures the alignment between the observed aspects and the developed instructional material draft. In contrast, face validity gathers feedback from potential users regarding the developed draft [13].

The content validity involved ten experts in chemistry and chemistry education. The data collection instrument used was an assessment sheet that included several observed aspects: the accuracy of relating real-life situations or conditions with the studied concepts, the accuracy of the written materials, illustrations, and videos according to the experts' conceptions, the accuracy of the application of concepts in everyday life or scientific advancements, and accuracy of applying concepts in unfamiliar contexts or problems. The participants provided ratings for each aspect using four categories: not usable (score 1), in need of significant revisions and less relevant (score 2), relevant with minor revisions (score 3), and highly relevant (score 4). The data obtained were then used to calculate the Content Validity Index (CVI) for each aspect by dividing the number of experts rated as relevant (scores 3 and 4) by the total number of experts. The draft is considered valid if all aspects obtain a minimum CVI value of 0.8 [14]. If any aspect receives a CVI value below 0.8, revisions will be made based on the experts' suggestions and feedback.

The participants involved in the face validity assessment were 25 s-year students majoring in chemistry education who had studied the concept of colligative properties of solutions. The data collection instrument was an assessment sheet that contained statements of agreement or disagreement for each practical aspect. The aspects observed included the content's attractiveness, clarity, novelty, videos, examples, and exercise questions in each section of relating, experience, applying, cooperating, and transferring within the draft product. The results obtained were then used to determine the percentage of agreement from the potential users. The draft product can be used in learning if it obtains a minimum agreement of 80%. If any aspect falls below 80%, revisions will be made based on the suggestions and feedback of the potential users.

2.4 The Implement and Evaluate Stage

The implementation stage involves 65 students from the Chemistry Education program at FKIP Untan taking the Solution Chemistry course, explicitly focusing on the colligative properties of solutions. Prior to the start of the instruction, students are provided with the validated flipbook. Subsequently, the students can utilize the developed flipbook during both in-class and out-of-class learning activities. The Evaluate stage is conducted after the instruction on colligative properties, wherein the students' responses are assessed following their use of the REACT-based flipbook on colligative properties of solutions during the course.

The data collection instrument used is a questionnaire on using the flipbook to learn solutions' colligative properties. The observed aspects include ease of use, information retrieval, task completion, additional references, insight into the relevance of concepts to everyday life and scientific advancements, clarity of information, challenges in problem-solving, and meaningfulness of the material being studied. All observed aspects are presented in positive statements using a Likert scale with response options ranging from strongly agree, agree, neutral, and disagree to strongly disagree, represented by values 4, 3, 2, 1, and 0, respectively. The obtained data is then calculated as the percentage of responses by dividing the total score for each aspect by the maximum score and multiplying it by the number of respondents. The resulting percentages are categorized according to Table 1.

Table 1. Response categories are based on the percentage of response values.

Score Range	Category
86%–100%	strongly agree
71%–85%	agree
56%–70%	neutral
41%–55%	disagree
<40%	strongly disagree

3 Results and Discussion

3.1 The Analysis Stage

The first stage begins with analysis, which involves analysis the problems faced by chemistry education students at FKIP Untan in learning the concept of colligative properties of solutions. The results obtained from interviews with ten students revealed that understanding the concept of colligative properties of solutions tends to focus only on calculations using existing formulas. Exploratory activities are minimal, especially experimental or discovery activities related to measuring vapour pressure, freezing point, boiling point, and osmotic pressure. In addition, discussions on applying concepts in everyday life and scientific advancements are rarely conducted. The application of colligative properties of solutions is only discussed in using coolant solutions in car radiators, utilizing the concept of lowering the boiling point of the solution. In contrast, vapour pressure, boiling point elevation, and osmotic pressure are not addressed. The learning pattern consists of memorizing formulas and studying example problems provided by the lecturer.

3.2 The Design Stage

Based on the results obtained in the analysis stage, the next step is to design learning materials that can connect real-life phenomena with the concepts to be learned and their applications in everyday life. Presenting relevant phenomena or applications related to the learned concepts can enhance interest and promote long-lasting retention in memory [15, 16]. Additionally, providing problem-solving tasks that are practical and directly useful in daily life can motivate students to solve problems, utilize their existing knowledge and information, and devise solution plans considering various possibilities [17, 18].

In the design stage, the REACT approach is chosen because it provides an opportunity for students to connect the learned concepts with real-life phenomena and applications, as well as develop critical thinking skills to apply their knowledge to new problems beyond the given context [16, 19]. The concept of colligative properties of solutions is divided into three parts: vapour pressure lowering, boiling point elevation and freezing point depression, and osmotic pressure. Each part begins with relating, experiencing, and applying and concludes with cooperating and transferring.

In the relating stage, students are given a real-life phenomenon related to the learned content in the form of descriptions or texts accompanied by relevant videos. The experience stage aims to build students' understanding of the concepts through exploration activities, such as observing material descriptions with accompanying images, laboratory experiment videos, and providing example problems with solution steps. The applying stage aims to allow students to understand the application of concepts, which consists of two types: application to scientific advancements and application to solving everyday life problems. The final stage of each topic is cooperating and transferring, where students are presented with problems in new contexts or situations that can be solved using the colligative properties concepts they have learned. The flow or storyboard of the flipbook draft to be developed is presented in Table 2.

Table 2. Developed REACT approach flipbook storyboard.

The REACT Approach	vapour pressure lowering	boiling point elevation and freezing point depression	osmotic pressure
Relating	Introduction to the principle of a pressure cooker related to the vapour pressure of liquids	Introduction to coolant fluid in car radiators and its relation to the boiling point and freezing point of the fluid	The prohibition of directly drinking seawater is related to the phenomenon of osmosis.
experiencing	It Performs an observation on the experiment of measuring vapour pressure, relating it to temperature increase, and determining the vapour pressure of volatile and non-volatile solutions.	It Observes boiling and freezing phenomena, analyzing phase equilibrium of different gas states, determining the magnitude of boiling point and freezing point elevation in non-electrolyte solutions, and the anomaly exhibited by electrolyte solutions.	It Observes the phenomenon of osmosis and determines the magnitude of osmotic pressure in non-electrolyte and electrolyte solutions.
applying	It Applies the concept of vapour pressure in seawater desalination and fractional distillation.	It Applies the concept of freezing point depression or boiling point elevation in determining the relative molecular mass of a solute and the degree of ionization of a weak electrolyte.	Applying the concept of osmotic pressure in creating intravenous fluids, reverse osmosis desalination of seawater, and determination of the relative molecular mass of macromolecules.

(*continued*)

Table 2. (*continued*)

The REACT Approach	vapour pressure lowering	boiling point elevation and freezing point depression	osmotic pressure
cooperating and transferring	It Analyses the relationship between mole fraction and pressure from the graph of fractional distillation condensation, analyses the advantages and disadvantages of solar distillation compared to fossil fuel distillation, and predicts the vapour pressure equilibrium of two or more solutions in a closed system.	It Analyses the limitations of boiling point elevation measurements in determining relative molecular mass, analyses the assumption of identical properties of two solutions based on freezing point data, analyses the percentage composition of two or more compounds in a solution based on freezing point data, predicting the freezing point depression of a solution composed of two or more non-volatile solutes.	It Analyses errors in measuring the relative molecular mass of macromolecules using osmotic pressure, predicting the osmotic pressure exerted by two or more solutes in a solution, predicting the percentage of compounds in a mixture of several solutes, predicting the amount of seawater required in reverse osmosis desalination.

3.3 The Develop Stage

After creating the storyboard, the next step is to develop a flipbook on the colligative properties of solutions using the REACT approach. The developed flipbook can be seen in Fig. 1.

After developing the flipbook, the next step is to validate the content of the flipbook draft with ten experts, consisting of five chemistry experts and five chemistry education experts. Content validity aims to measure the extent to which the observed aspects are relevant to the targeted objectives from an expert or scientific perspective [14, 20]. In this study, the experts who evaluated the product were five chemistry experts and five chemistry education experts. The obtained results are presented in Table 3.

Based on Table 3, it is known that the developed draft of the colligative properties flipbook is valid for each measured aspect. The results reveal that the text, videos, and images in each relating, experiencing, and applying stage follow the experts' conceptions (without eliciting misconceptions) and align with the concepts or topics being discussed. Furthermore, the problems in the cooperating and transferring stages are distinct and new, separate from the context and different from the problems addressed in the relating, experiencing, and applying sections. The flipbook incorporates text, images, and videos in the relating, experiencing, and applying stages. The purpose of providing videos is to clarify abstract text or descriptions, make them more concrete, and visualize the narrative. Videos can also assist readers in saving time while reading the narration or text [21–23].

Face validity aims to measure the readability level of the developed flipbook from the perspective of second-year students who have studied the concept of colligative properties of solutions according to their level of understanding, experience, and learning habits [24, 25]. The results obtained from the face validity are presented in Table 4.

Based on Table 4, it is evident that the respondents have approved of each observed aspect. The developed flipbook is well-received by the respondents. It aligns with their characteristics, thereby avoiding gaps between the assessments from the expert's perspective and the potential users' perspective [26]. Thus, the potential barriers that could hinder the understanding of the content or message conveyed by users with different knowledge, experiences, and learning habits, even though it was deemed appropriate based on the expert's perspective on content validity, have been minimized [27].

Based on the content and face validity results, it can be concluded that the developed flipbook on colligative properties is valid and suitable for use in learning. Before the implementation phase, students must download the developed flipbook for free from the website https://bit.ly/FlipbookColligativeProperties.

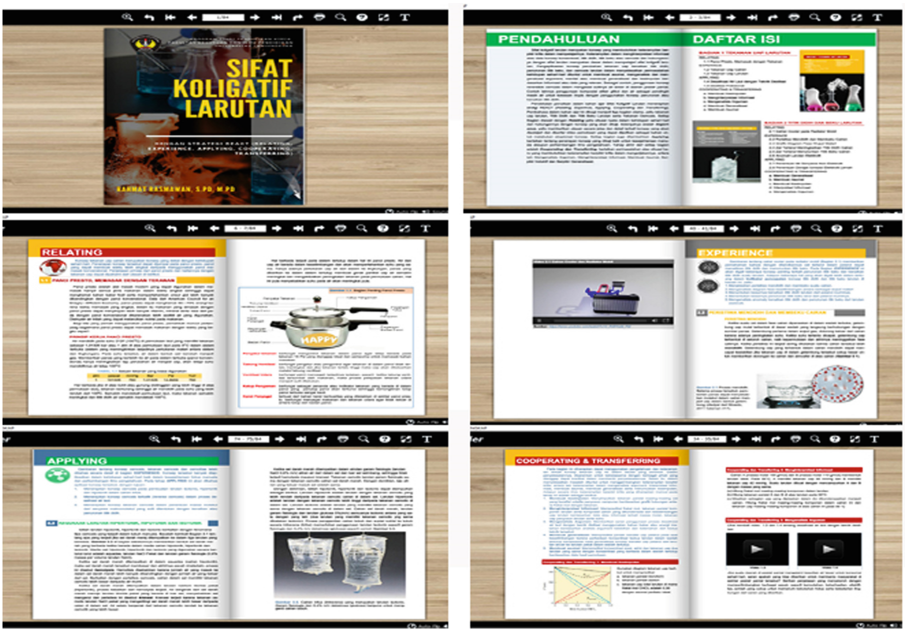

Fig. 1. Example display of a developed flipbook draft.

Table 3. Content Validity of the developed flipbook on colligative properties of solutions

The REACT Approach	Aspects Observed	relevant	Irrelevant	VCI	Category
Relating	Accuracy of events or conditions with the concepts of experts (avoiding misconceptions)	10	0	1	Valid
	Accuracy of events or conditions with the concepts being studied	9	1	0,9	Valid
	Accuracy of content in text, images, and videos depicting events or conditions	9	1	0,9	Valid
Experience	The accuracy of concepts studied with the understanding of experts (without misconceptions)	10	0	1	Valid
	The accuracy of the sequence of delivery, starting from prerequisites towards complex concepts	10	0	1	Valid
	The accuracy of the content of the description, images, and videos in delivering concepts	10	0	1	Valid
Aplying	The accuracy of applying concepts following the experts' understanding	10	0	1	Valid
	The accuracy of applying concepts based on the studied material	9	1	0,9	Valid
	The accuracy of the content in texts, images, or videos in delivering the application of concepts	10	0	1	Valid
Cooperating dan Transferring	Providing different problems from the sections of relating, experiencing, and applying	9	1	0,9	Valid

(*continued*)

Table 3. (*continued*)

The REACT Approach	Aspects Observed	relevant	Irrelevant	VCI	Category
	The problems being solved require high-level reasoning	8	2	0,8	Valid
	The problem statements are clear and do not bring about multiple interpretations	9	1	0,9	Valid

Table 4. Face validity of respondents towards the developed flipbook for develop stage

Aspect	Agreement	Category
The introduction at the beginning of the book provides an overview of what will be learned.	92%	adequate
The descriptions in the relating, experience, and applying stages are clear and easy to understand.	84%	adequate
The relating, experience, and applying videos help us understand the explanations.	92%	adequate
The events or situations in the relating section are directly related to everyday life, making them enjoyable to study.	96%	adequate
The explanations of the concepts in the experience stage are apparent and facilitate the understanding of the concepts being learned.	88%	adequate
The descriptions in the applying stage broaden the insights into the practical application of the concepts being studied.	88%	adequate
The examples and step-by-step solutions of the exercise questions in the experience and applying stages are easy to understand	92%	adequate
The problems in the cooperating and transferring stages take much work to solve.	84%	adequate
The interconnection between the concepts learned is utilized in solving the problems in the cooperating and transferring stages.	92%	adequate

3.4 The Implement and Evaluate Stage

During the implementation phase, 65 students enrolled in the Solution Chemistry course, explicitly studying the sub-topic of colligative properties of solutions, were involved in the research. The learning process took place over three sessions; each allocated 120 min. The students used the downloaded flipbook on colligative properties for their learning activities. The concepts covered in the first, second, and third sessions were vapour pressure, boiling point elevation and freezing point depression, and osmotic pressure. The learning activities included question-and-answer sessions, discussions, and assignments. The question and answer sessions and discussions took place within the classroom, with

Table 5. Face validity of respondents towards the developed flipbook for implement and evaluate stage

Aspect	Response	Category
The provided flipbook is easy to use on both computers and laptops.	90%	strongly agree
The flipbook can be used to explore information about the learned concepts.	86%	strongly agree
The flipbook can be used to explore information about the application of concepts in everyday life.	83%	agree
The flipbook can help assist with the completion of assigned tasks.	85%	agree
The flipbook can be used as an additional reference alongside textbooks for academic purposes.	83%	agree
The flipbook can broaden insights into the connection between concepts and everyday life and the advancement of knowledge.	85%	agree
The descriptions in the flipbook are apparent and easy to understand.	91%	strongly agree
The problems provided in the flipbook are very challenging to solve.	80%	agree
The material on the colligative properties of solutions presented in the flipbook is handy in everyday life.	87%	strongly agree

the instructor focusing on the explanations and content of the flipbook. The assignments related to problem-solving in the cooperating and transferring stages were completed outside the classroom. After completing the learning activities on colligative properties of solutions, the next step was to provide a questionnaire to gather feedback on using the developed flipbook. The results of the student's responses are presented in Table 5.

Based on Table 5, it is evident that the students responded positively after being taught using the developed flipbook. The developed flipbook influences students' learning conceptions in chemistry, focusing on memorizing and understanding concepts and applying and practising the acquired knowledge in everyday life or scientific developments. This approach enables students to gain meaningful and applicable new knowledge that can be understood and applied [28]. Another positive response from the users is their interest in solving real-life problems and engaging with scientific advancements, which ultimately encourages them to focus more on the studied topics and discover suitable approaches to solve them [29, 30].

4 Conclusion

This research has produced a valid REACT-based flipbook that effectively connects the learned concepts and their application in real-life situations and scientific developments. The flipbook demonstrates strong content validity, as its text, videos, and images align with expert conceptions and the discussed topics in each stage of relating, experiencing, and applying. Additionally, it introduces new and contextually diverse problems, going beyond the examples and exercises covered. The flipbook also exhibits good face validity, providing explicit and insightful content that enhances understanding and application of the learned concepts. Implementing the flipbook in the learning process garnered positive user responses, with students finding it user-friendly on various devices, helpful in acquiring information, completing assignments, and serving as an additional reference to expand their understanding of how concepts relate to everyday life.

One limitation of this study is the need to measure students' conceptual achievement after learning with the flipbook. This research focused solely on user responses to the developed flipbook. Therefore, it is highly recommended that future researchers assess how students grasp the concepts after being taught using the flipbook. Another limitation is the limited involvement of experts in providing assessment and feedback for content validity. Employing techniques such as the Delphi method to facilitate intensive interaction between the researcher and the involved experts is strongly recommended. Despite these limitations, we suggest using the developed flipbook in instruction, emphasizing the application of concepts in everyday life rather than solely delivering a set of concepts students need to master.

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