Enhancing Critical Thinking of Prospective Science Teachers Through H5P-based Formative Feedback in the ALLR Model

W. WIDODO, L. ROSIDANA, D. A. P. SARI, A. F. HENDRATMOKO

ABSTRACT

Introduction. Formative feedback is widely acknowledged for enhancing student learning outcomes, yet its implementation through LMS-integrated technology to support critical thinking remains under-researched. *This study examines* the efficacy of H5P, an interactive content tool within a Moodle-based LMS, in enhancing the critical thinking skills of prospective science teachers in a Fundamentals of Science course.

Research methods and participants. This quantitative study employed a one-group pretest–posttest design with three replications. The participants consisted of 403 prospective science teachers from a state university in East Java, Indonesia, selected through purposive random sampling. They were divided into three classes: 29 students in Class A, 32 in Class B, and 27 in Class C. Critical thinking skills were measured using the Facione test instrument administered before and after the intervention. Data analysis involved N-Gain scores, paired sample t-tests, and One-Way ANOVA. Additionally, two types of questionnaires were used to assess student responses.

Results. The integration of formative feedback through H5P within a Moodle-based LMS significantly enhanced the critical thinking skills of prospective science teachers enrolled in the Basics of Science course. N-Gain scores varied across classes: Class A (moderate, 0.448), Class B (high, 0.721), and Class C (moderate, 0.304). A paired t-test confirmed significant pre-post improvements, while a One-Way ANOVA indicated notable differences across groups. Pedagogically, the intervention draws on the principles of activity-based and reflective learning embedded in the ALLR model, where H5P's interactive feedback mechanisms provided timely, individualized responses that fostered student reflection and deeper cognitive engagement. This formative, feedback-driven approach aligns with constructivist learning theories, emphasizing learner autonomy and iterative knowledge building. Over 70% of students reported high satisfaction, affirming the relevance and effectiveness of the digital content. These results suggest that the integration of structured reflection, active learning tasks, and real-time digital feedback creates a pedagogically sound environment that effectively cultivates critical thinking and engagement in teacher education.

Conclusion. This study demonstrated that the use of formative feedback, enhanced through H5P within a Moodle-based LMS, effectively improved the critical thinking skills of prospective science teachers in the Basics of Science course. Additionally, students responded positively to both the quality of the learning media and the overall learning experience.

KEYWORDS

critical thinking, formative feedback, H5P, prospective science teachers

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INTRODUCTION

Critical thinking is a very important skill in the student learning process, which also serves as a primary indicator in measuring their academic success [1]. The study showed that students' critical ability can improve their performance in their work environment [2]. Amidst rapid technological advances and social change, the challenges faced by the younger generation are increasingly complex, so critical thinking skills become a necessity [3]. High-level critical thinking involves a rational, introspective approach, and the ability to interpret and analyze information in depth [4]. Expert state that critical thinking is purposeful and self-regulatory judgment that leads to interpretation, analyses, evaluation, inference, and explanations about the considerations of evidence, conceptual, methodological, criteriological, or contextual form the basis of the judgment [5]. To achieve success in the professional world, students need more advanced cognitive skills [6]. Thus, education in schools should teach these critical thinking skills [3]. Some schools even aim to not only teach science but also to develop critical thinking skills as a way to improve the world [7]. The study showed that pre-service teachers understand to some extend about critical thinking, but there are some misconceptions. However, they are willing to integrate critical thinking into their classrooms, despite many obstacles [8]. In Indonesia, children who grow up with Pancasila values also need high-level cognitive skills to contribute to the global community [9]. Other developed countries also emphasize the importance of high-level thinking in the graduation process as preparation for the increasingly challenging professional world [10]. Therefore, developing critical thinking skills is very important in education to ensure that students can adapt and succeed in facing increasingly complex global challenges.

To foster critical thinking in science teachers, students must first engage in the Basics of Science course. This course encompasses a wide range of topics, including natural sciences, scientific inquiry, science process skills, physical environments, the living world, matter particles, matter changes and reactions, science values, science thinking skills, and scientific literacy. Additionally, the course encourages exploration through resources such as the sindig.unesa.ac.id website, which is recommended for further training in these areas.

In addition to participating in coursework, critical thinking can be further enhanced through formative evaluation and feedback, which play a vital role in global educational reform initiatives [11]. Formative assessment has been shown to be essential in the learning process by promoting deep learning experiences, establishing achievement standards [12], enhancing students' learning outcomes, and helping teachers adjust their instructional strategies to better meet students' needs. Formative assessment gives feedback to determine further action for both teachers and students [13]. It also helps to identify students who need support during their learning [13]. However, the effectiveness of formative assessments is influenced by some factors, such as students' personal learning, teachers' professional development and availability of teaching resources [14].

Bloom (1968) emphasized the importance of formative assessments for providing feedback to students [15]. Formative evaluation, by its nature, necessitates feedback [16]. It is recognized as an effective tool [17; 18], one of the most powerful influence on learning and achievement [17], crucial for enhancing learning [19], and contributing to overall academic improvement [20]. For formative assessments to be truly impactful, teachers must deliver high-quality feedback [16]. This feedback should be meaningful and effective, helping students grasp learning objectives, simplifying reflective activities, facilitating the exchange of valuable information and knowledge, motivating students, and ensuring that feedback is provided at the most opportune moments.

Providing feedback, whether immediate or delayed, has a significant impact on student learning [21]. High-quality and timely feedback can boost students' motivation, reduce the likelihood of repeating mistakes [22], enhance their understanding of the material, and improve overall performance. Furthermore, prompt feedback encourages student engagement in the learning process and supports the attainment of educational objectives [23]. Research indicates that students who anticipate receiving timely performance feedback tend to achieve higher scores compared to those who do not have such expectations.

Formative assessment can be effectively combined with technology to deliver learning materials and interactive evaluations [24]. Technology also facilitates the provision of formative feedback to learners [25]. Several academic studies have explored the use of technology in providing constructive feedback. These studies have implemented web-based formative feedback systems through utilizing isomorphic items [26], the promising potential of Writing & Audit to five automated formative feedback [27], and delivered formative feedback through email on assignments for English as a Foreign Language (EFL) students [28], utilized Weekly Formative Video Feedback to enhance the experiences of pre-service teachers [29] and integrated game-based technologies to further engage students in the learning process.

In 2020, experts developed Gadget-Based Interactive Multimedia to enhance scientific literacy among Generation Z. In 2021, the same multimedia approach was utilized to address Socio-Scientific Issues and improve scientific literacy in elementary students. Both applications incorporate lesson content and formative feedback, which are designed to assess and support students' development of scientific literacy.

Gadget-Based Interactive Multimedia, a formative assessment method that provides feedback, has proven effective in improving scientific literacy among both pre-service teacher [30] and elementary students [31]. However, the interactive multimedia platform is not integrated with university Learning Management Systems (LMS), which limits its accessibility for science teachers. LMS platforms can facilitate both online and offline learning through blended learning approaches. These systems allow for the management, organization, and delivery of online learning content, enhancing the flexibility and efficiency of online and remote education [32]. Technology plays a crucial role in helping both teachers and students organize and access instructional materials. Despite these benefits, few studies have explored the use of formative feedback within LMS platforms.

HTML5 Package (H5P) is a prominent e-learning media that leverages information and communication technologies. It provides an engaging, interactive, and easily accessible platform for developing e-learning content across various devices. H5P offers interactive features such as gamification and multimedia elements, which can be created collaboratively and shared across networks. Content developed with H5P can be seamlessly integrated with a range of Learning Management Systems (LMS) and other educational platforms, including Moodle, Canvas, WordPress, and Drupal, enabling users to incorporate interactive content into their existing learning environments with ease.

Based on analysis, H5P is user-friendly, enhances students' attention and interest in learning, and contributes to improved learning outcomes [33]. As a result, H5P-based learning media is both effective and efficient for various educational activities. H5P has also proven to be effective in building students' self-confidence when explaining scientific concepts in biology [34]. Furthermore, H5P can support aspiring science instructors in fostering critical thinking through formative feedback, and it enhances the effectiveness of online learning [35]. In another study, the H5P platform was utilized for virtual simulation and gamification for nursing students [36]. However, despite numerous studies on formative feedback and media usage, there has been limited research specifically exploring formative feedback through H5P.

H5P utilizes a Moodle-based Learning Management System (LMS) along with the ALLR (Activity-based, Lesson Learn, Reflection) learning model in the Basics of Science course to explore how formative feedback enhances prospective teachers' critical thinking. The ALLR model encourages students to assess, learn, and reflect using cognitive, emotional, and psychomotor traits [37]. The steps in the ALLR learning model are as follows: 1) Informing students about the phenomenon or problem to investigate; 2) Planning the investigation or problem-solving process; 3) Supervising the investigation or problem-solving process; 4) Sharing the results; 5) Reflecting on the value of the lesson; and 6) Reflecting on the entire process. This model aims to support deep learning and critical thinking through structured feedback and reflective practices.

THEORETICAL BACKGROUND

1. Critical Thinking Skills

Critical thinking is one of the important skills in 21st-century education, especially for prospective science teachers. Critical thinking is “reasoned, reflective thinking focused on deciding what to believe or do" [38]. Ennis identified five main aspects of critical thinking, namely basic clarification, the bases for decision, inference, advanced clarification, and strategies and tactics [38]. Critical thinking includes the ability to analyze, evaluate, dan synthesize information and have self-awareness of one's thinking processes [39]. Fisher (1997) claims that metacognition is an important aspect that can be achieved by some conscious effort by reference to a good model of thinking [40]. Thus, critical thinking must be taught. Furthermore, Fisher (1997) states that critical thinking skill must be exercised and be applied not only in academic studies, but also in many situations (where appropriate) [40].

2. ALLR Learning Model (Activity Based, Lesson Learn, and Reflection)

The ALLR is a learning model that integrates direct experience based on activities, reflection, and meaningful learning [41]. Activity-based learning allows students to be actively involved in experiential learning through problem-solving activities. The lesson learned focuses on identifying new knowledge gained from the experience. Reflection encourages students to evaluate and be aware of their thinking processes. This learning model is rooted in constructivism theory, which states that knowledge is built through active experience and reflection [42].

3. Formative Assessment

Black and Wiliam (2010) define formative assessment as any activity that provides information to adjust teaching to meet students' learning needs. Formative assessment implemented in effective learning when (a) carried out continuously during the learning process, (b) accompanied by formative feedback, not just grades, and (c) followed by follow-up by teachers and students. The follow-up of formative assessment by teachers is in the form of adaptation of learning instructions and learning strategies [43]. Meanwhile, student follow-up is in the form of reflective activities by students to improve their understanding. Black and William (2010) state that feedback is said to be good if (a) given immediately after the learning activity, (b) Specific and focused on aspects that need to be improved, not just stating "good/bad," (c) shows improvement and strengths, not just weaknesses, and (d) motivates students to rethink and act (actionable feedback) [43]. In addition, Carless and Boud (2018) states that effective feedback is feedback that meets the following criteria: (a) causes uptake, namely students make changes or improvements, (b) is dialogic, involving two-way communication between teachers and students, and (c) encourages student agency in the learning process [44].

4. HTML5 Package (H5P)

H5P is a web-based HTML5 Package platform that allows teachers to create interactive content. Interactive content includes: (a) Interactive videos (videos with questions and direct feedback), (b) Quizzes with instant feedback (quizzes with direct explanations), and (c) Essay questions with guided reflection [45]. H5P allows the integration of automatic feedback based on user responses. H5P facilitates activity-based learning, encourages reflection, and provides direct feedback in the application of the ALLR learning model. For example, in interactive videos, H5P can raise questions for users. Meanwhile, the responses obtained by users (students) differ depending on the answers given. This can help form learning loops that improve critical thinking skills.

MATERIALS AND METHODS

This is quantitative research using a one-group pretest and post-test design [46], with three replications in classes A, B, and C. Research with this design involves measurements (with a pretest) before treatment or intervention is given, then measured again (with a posttest) after treatment or intervention. This design aims to see whether there are changes or influences after treatment is given to research subjects, focusing on improving critical thinking skills.

The population of this study was 403 prospective science teachers at a state university in East Java, Indonesia. Furthermore, the sample was selected using the purposive random class method. Based on this method, three categories were selected, namely 29 students in class A, 32 in class B, and 27 in class C.

SIDIA UNESA Moodle-based LMS uses H5P to produce interactive learning media with automatic formative feedback. ALLR learning model included students' orientation to the phenomenon or problem, investigation or problem-solving process design, guidance for investigation activities or method application, presentation of inquiry or problem-solving results, lesson value extraction, and learning process reflection [37]. Interactive films and seminars covered science concepts and tests. These instruments supported critical thinking throughout scientific research. Fundamental indicators of thinking formative assessment contextualized multiple-choice questions in scientific research [5].

Formative feedback from H5P media used four-answer multiple-choice questions. All questions had interactive videos. Clicking the answer gives students automatic feedback. This feedback provides the correct solution to assist students evaluate their responses. Formative exam results included achievement scores and study advice for correcting incorrect answers. Students can retry the formative evaluation and see the solution on the website. H5P-based formative feedback is presented in Figure 1 below.

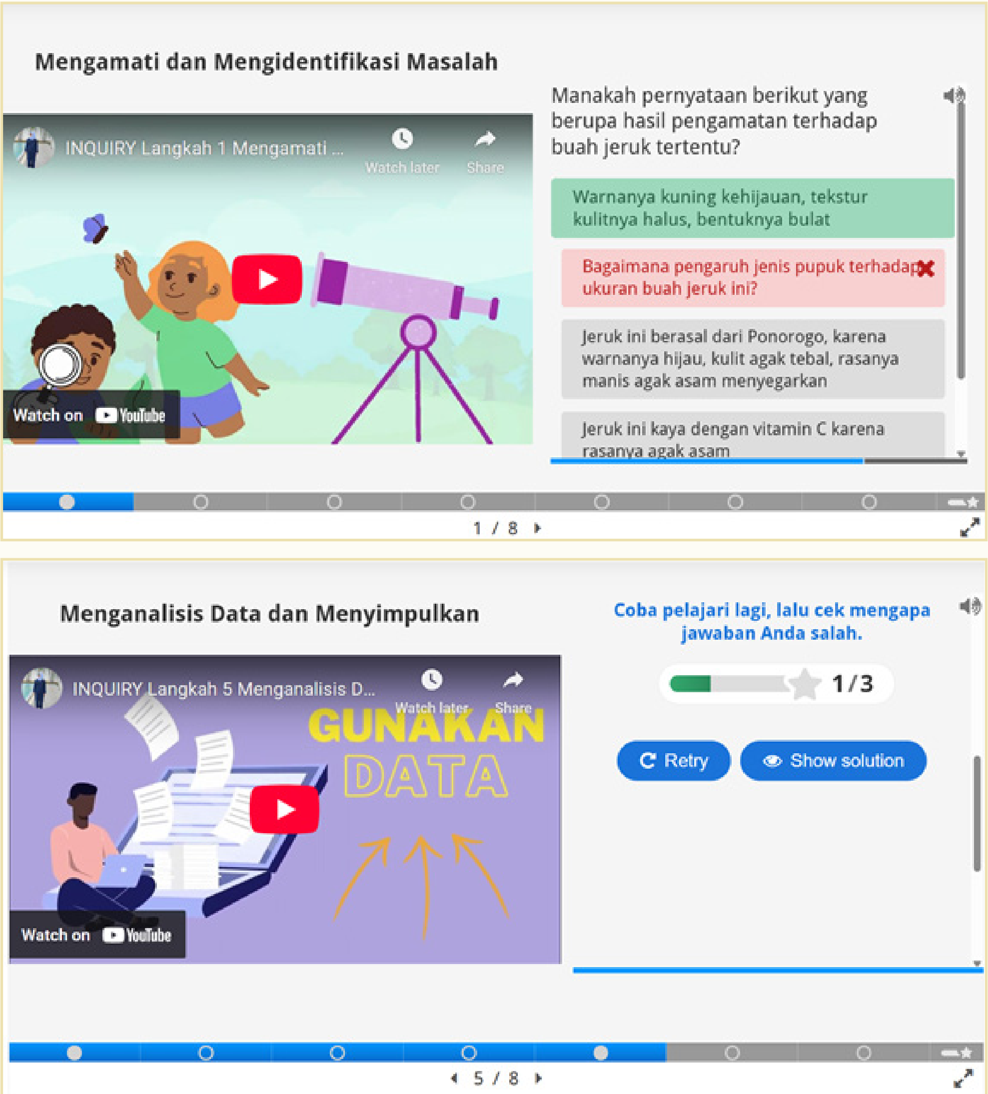

Figure 1 Display of H5P learning media

The application of formative feedback, as presented in Figure 1, is based on the ALLR learning model, which provides a structured pedagogical framework aimed at enhancing critical thinking. This model consists of three phases [41]:

- Activity-Based Learning: Students engaged in exploratory science tasks either individually or in small groups, designed to stimulate inquiry and initial reasoning.

- Lesson Learn: After completing the activity, students interacted with digital learning content, including H5P-enhanced materials embedded in the Moodle LMS. These materials featured four-answer multiple-choice questions embedded in interactive videos. When students selected an answer, they received immediate, automated feedback with explanations, correct reasoning, and hints for self-correction.

- Reflection Phase: Students revisited their performance through formative evaluation summaries, which included their achievement score, suggested review topics, and the opportunity to retry tasks. The ability to access feedback at their own pace allowed for metacognitive reflection and deeper understanding.

The pedagogical approach emphasized learner autonomy, formative assessment, self-regulation, and feedback for learning, in line with Vygotskian and constructivist principles. Teachers acted as facilitators, guiding students through the process and encouraging reflection on errors and reasoning. These pedagogical conditions, interactive digital content, student-centered learning cycles, and structured feedback, collectively created an environment conducive to developing higher-order thinking skills.

Three scientific and learning media professionals validated H5P learning media. Content, presentation, and language were assessed for validation. Tools for assessing critical thinking were used. Cronbach Alpha showed a reliability of 0.717, exceeding the 0.60 threshold and placing the test in the reliable category [47]. descriptive analysis was performed on critical thinking abilities test results [48]. This analysis calculated mean, SD, and N-gain.

Inferential analysis was conducted using the mean difference test on the results of the critical thinking skills test. Meanwhile, to test the consistency of the increase in students' critical thinking skills in classes A, B, and C, a One-Way ANOVA test was conducted on the N-Gain scores obtained by students in the three classes. This was done to ensure whether there was a difference in the increase in students' critical thinking skills after being given the same treatment.

Student responses were collected using two questionnaires. The quality of H5P learning media was assessed using a Likert scale in the first questionnaire. The second open-ended questionnaire obtained students' opinions about H5P learning media activities. Response data were examined using percentages to determine the correlation of student agreement with claims.

RESEARCH RESULTS

1. Critical Thinking Skills of Prospective Science Teachers

Data about students’ critical thinking skills were derived from the average scores obtained in the pretest and post-test. Descriptive analysis was conducted by calculating the mean, SD, and N-gain to analyze the data as follows.

Table 1

Descriptive analysis results

Test	Mean	N	SD	Standard Error Mean	N-Gain
Pretest A	11.0000	29	2.42015	.44941	0.448276
Posttest A	15.0345	29	2.77080	.51452	
Pretest B	10.9375	32	2.60195	.45996	0.72069
Posttest B	17.4688	32	2.77063	.48978	
Pretest C	11.9630	27	2.51887	.48476	0.304147
Posttest C	14.4074	27	3.10408	.59738	

Table 2 shows that H5P with ALLR learning model improved mean pretest and post-test results for the three experimental courses. Average class A score improved from 11.0000 to 15.0345, with medium N-gain 0.448276. The average class B score rose 10.9375 to 17.4688. This improved N-gain rating of 0.72069 was impressive intellectually. Average Class C scores rose from 11.9630 to 14.4074, with medium N-gain 0.304147. Results were inferred using the mean difference test following descriptive analysis. See Table 3 for the normality assumption test before the mean difference test.

Table 2

Normality test results

	Kolmogorov-Smirnov a			Shapiro-Wilk		
	Statistics	Df	Sig.	Statistics	df	Sig.
Pretest_A	.148	27	.131	.957	27	.317
Pretest_B	.134	27	.200 *	.945	27	.161
Pretest_C	.161	27	.070	.931	27	.075
*. This is a lower bound of the true significance.						
a. Lilliefors Significance Correction						

All rejected significance values were above 0.025. Since the data were evenly distributed, the assumption that the 3 sample classes were from an average population was supported. Table 3 shows an inferential mean difference test in the three trial classes.

Table 3

Mean difference inferential test results

		Paired Differences					Q	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest A – Pretest A	-4.03448	3.01760	.56035	-5.18232	-2.88665	-7,200	28	,000
Pair 2	Pretest B – Posttest B	-6.53125	3.80140	.67200	-7.90180	-5.16070	-9,719	31	,000
Pair 3	Pretest C – Posttest C	-2.44444	3.58773	.69046	-3.86370	-1.02519	-3,540	26	,002

The table shows a significant difference in pretest and post-test results for each trial class. The average pretest and post-test showed critical thinking skills of prospective science teachers improved after using H5P with the ALLR learning model. Therefore, H5P learning media formative feedback could improve these skills.

Table 4

Test of homogeneity of variances

N-Gain			
Levene Statistic	df1	df2	Sig.
.713	2	85	.493

Table 4 shows the homogeneity of the data used in the study. The homogeneity of the data is very important to ensure that the samples analyzed come from groups that have similar characteristics so that the results obtained are reliable. In the table, the variance between groups is quite consistent, indicating that the data collected does not have significant differences between one group and another. Thus, it can be concluded that the data used in this study meets the assumption of homogeneity, which is a crucial initial step in further statistical analysis.

The treatment given in this study has been proven to improve students' critical thinking skills. However, the results of further analysis found inconsistencies in improving critical thinking skills. The results of the One-Way ANOVA test showed differences in the average increase in critical thinking skills of students in classes A, B, and C (see Table 5).

Table 5

The results of the one-way ANOVA test

N-Gain					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.561	2	.781	7.719	.001
Within Groups	8.596	85	.101		
Total	10.157	87			

2. Prospective Science Teachers' Responses to H5P Learning Media with ALLR Learning Model

The opinions of prospective science teachers regarding the quality of H5P learning media were evaluated in terms of the following aspects: (1) material relevance, which refers to the relationship between the material and the concepts discussed in H5P learning media, (2) the material's ability to hone critical thinking skills, and (3) the skills to understand the response tests that measure critical thinking based on users' interactions. The response results are presented as follows.

Table 6

Opinions of prospective science teachers on H5P learning media

No.	Aspect	Percentage Approval (%)			Average Percentage (%)
		Class A	Class B	Class C	
1	Material relevant to concepts discussed.	66.67	90.63	86.21	81.17
2	Material hones the skills to think critically.	66.67	81.25	79.31	75.74
3	Understanding the skills of response tests to measure critical thinking based on users' interactions.	66.67	78.13	75.86	73.55

Over 70% of students approved of each area of H5P learning media quality, as seen in the table. 81.17% of students said the content was related to the topics and 75.74% said it may improve critical thinking. Lastly, 73.55% found the critical thinking response exam based on user interactions simple. Prospective science teachers' perspectives after using H5P learning media are as follows.

Table 5 shows use, content, and appearance opinions. The internet network limited pupils, H5P learning media was available, loading was delayed, and the program ended abruptly. Students recommended pretest and post-test completion. This may help students schedule art time. Post-test questions should include comments to help students learn from mistakes. Student suggestions included adding animations to H5P learning medium for appearance and engagement. Results showed flexible and accessible learning material. We assessed H5P learning activities with a questionnaire and an open questionnaire. We wanted all input. Students loved well-organised, fun, and engaging learning exercises that introduced new topics. The teachers' comprehensive explanations and willingness to clarify helped. Instructors closely observed learning exercises.

Table 7

Opinions of prospective science teachers regarding H5P learning media

<table>
<tr><th>No.</th><th>Necessary Things Fixed</th><th>Information</th></tr>
<tr><td>1</td><td>Internet network constraints cause slow programs to be accessed.</td><td rowspan="2">Use</td></tr>
<tr><td>2</td><td>It can also be accessed through cell phone.</td></tr>
<tr><td>3</td><td>There should be a notification when the task is about to be completed.</td><td rowspan="2">Contents</td></tr>
<tr><td>4</td><td>It is better to have feedback on the post-test questions for students to know where the answers are and ensure they study again.</td></tr>
<tr><td>5</td><td>More animation to make it interesting.</td><td>Appearance</td></tr>
</table>

DISCUSSION

There is a critical need to foster key learning outcomes, including the development of critical thinking [49; 50]. To address this, the current study employs H5P learning materials, combined with the ALLR learning model and formative feedback, to enhance critical thinking skills. This approach is consistent with previous research, which demonstrates that H5P can effectively promote the development of critical thinking [51]. Additionally, research highlights the significant role of formative assessment in tracking students' learning progress, understanding, and critical thinking abilities [52]. Formative assessment is particularly effective when integrated into e-learning platforms, enhancing the overall learning experience [53; 54] and making educational activities more effective and efficient [55]. Numerous studies have emphasized the positive impact of technology in formative assessment, particularly in improving learning outcomes [56].

In the current study, the formative assessment is integrated with automatic feedback, allowing students to receive immediate and direct responses to their answers. Previous research suggests that feedback is a crucial component of educational programs [57] and is especially critical in formative assessment [58]. Providing timely feedback has been shown to enhance motivation [59] and improve learning effectiveness [57]. Additionally, such feedback enables students to reflect on the values they have achieved and identify areas that need improvement [57]. Therefore, offering this type of feedback is an effective way to sharpen students' critical thinking skills.

Formative feedback refers to information provided to students aimed at altering their thinking or behavior to enhance the quality of their learning [60]. This feedback is typically given when students complete an assignment or activity, or when they provide a response. It suggest that the key to success in learning lies in students' perception of task relevance and the appropriateness of the feedback they receive [61]. Students who completed formative tasks were more likely to achieve an A grade, whereas those who did not submit formative work had a higher likelihood of failing [62].

Various research findings demonstrate that formative feedback plays a vital role in the construction and development of students' skills [63], particularly in enhancing cognitive processes and achieving learning objectives [64]. It has also been recognized as one of the most significant factors influencing learning [17]. By providing formative feedback, educators can help students monitor their progress, direct their learning with appropriate resources, and identify those who require additional support at an early stage [65]. Typically, formative assessment and feedback are essential for learning, as they contribute to improving students' problem-solving abilities, creativity, and critical thinking skills [66].

This study yielded interesting results, as the provision of H5P-based formative feedback in learning with the ALLR model proved effective in enhancing students' critical thinking skills. However, the observed improvement showed an average difference across the three classes used as trial sites. This variation is likely attributed to several factors, such as differences in students' initial levels of understanding, their skills and familiarity with the applications used, and their motivation and engagement in the learning process. Additionally, the learning environment and the social interactions between students can also influence the outcomes. Therefore, these factors must be carefully considered when designing more effective learning strategies to ensure a more consistent and impactful improvement in students' critical thinking skills.

Learning principles are essential for guiding the effective delivery of educational content. In this study, 81.17% of students agreed that the content delivered through H5P, combined with the ALLR learning model, was relevant to science and scientific inquiry. Research by [67] and [68] underscores the significance of concept relevance in learning activities for achieving educational objectives. This relevance not only sparks new insights but also empowers students to address real-world problems [69]. This finding aligns with previous research, which asserts that a strong understanding of concepts forms the foundation for grasping broader principles and theories [70; 71].

Previous research emphasizes that students' comprehension of information is crucial for enhancing their understanding of concepts [72]. On the other hand, grasping these concepts is essential for fostering students' critical thinking skills [73]. Studies have also shown that students' cognitive abilities are closely linked to their ideas and perceptions [74]. Building on this, the current study adopted the H5P platform combined with the ALLR learning model, with 75.74% of students agreeing that it significantly improved their critical thinking.

The development of learning media should prioritize user convenience. In this study, 73.55% of students agreed that the H5P learning media developed was easy to operate. This ease of use was designed to facilitate the achievement of the intended learning objectives, specifically enhancing the critical thinking skills of prospective science teachers.

Students using the H5P learning medium have expressed favorable responses, indicating their satisfaction and happiness. Previous research shows that critical thinking, intelligence, and creativity are all positively influenced by happiness [75]. Happier individuals tend to make better judgments and perform activities more effectively [76]. Moreover, studies have demonstrated that happy students perform better academically [77; 78]. Students' satisfaction with their learning experience is a crucial learning outcome [79] and serves as one of the most significant indicators of the quality of a learning environment.

Previous research has also highlighted that students respond positively to the explanations and guidance provided by lecturers, who play a significant role in teaching critical thinking skills [80]. This is because, when teaching critical thinking, lecturers take into account the social values and cultural norms of their students' communities, while also developing teaching materials, pedagogical tasks, and assessment practices that are culturally sensitive and contextually appropriate [81]. Additionally, some studies have shown that students often prefer lecturer-led learning approaches in the development of their critical thinking skills [82].

Most students felt that the H5P learning material enhanced their learning, comprehension, quality, and critical thinking skills. They were also able to apply principles to formative assessment tasks. The feedback provided through the H5P learning media was well-received, accessible, and supported students in their learning. Previous research shows that technology can significantly aid the learning process [83]. H5P is easily understood, allows for repeated study, and helps students grasp concepts and information. It makes learning more enjoyable, more effective, and efficient, while also offering an informal learning experience. This approach makes learning more dynamic, practical, and engaging, enabling students to access content anytime and anywhere, ultimately fostering the development of their critical thinking skills.

Despite its advantages, H5P also has some weaknesses. One major issue is slow and unstable internet access, which can lead to errors when accessing the platform and disrupt the continuity of learning activities. Since all H5P activities rely on a stable internet connection, this becomes a significant challenge for users [84]. Several studies have identified poor internet connectivity as one of the most considerable obstacles to digital learning when using H5P [84]. Another limitation is that the developed H5P content may not be fully optimized for mobile devices, which can hinder user comfort. Additionally, there is a need for more engaging animations and features to enhance the overall user experience.

Based on the identified weaknesses, several suggestions have been made to improve the H5P learning experience. These include increasing the variety and depth of the material, improving server performance to ensure smoother access, and making the design more visually appealing. Additionally, it would be beneficial to incorporate notifications to keep students informed. Furthermore, assigning tasks to students regularly will help them stay engaged and remember their responsibilities. Lastly, creating an app that is accessible through the Google Play Store would facilitate easy installation on both mobile phones and laptops, improving accessibility and user convenience.

CONCLUSION

In conclusion, this study showed that utilizing interactive learning media, specifically augmented by H5P, in the context of Moodle-based LMS in the Basics of Science lectures, proved to be effective in improving critical thinking skills of prospective science teachers. Students also responded favorably to the product's quality and learning experience. However, the existing H5P content needed to undergo further refinement and design enhancements to improve user-friendliness and aesthetic appeal, particularly for students' engagement. The implementation of the ALLR model in this framework contributed significantly to the learning process. By integrating activities that facilitated active participation, fostering an environment where students could reflect on lessons learned, and providing structured reflection opportunities, the ALLR model complemented the interactive H5P content. This model not only supported the development of critical thinking skills but also improved general learning experience, making it more holistic and reflective for students. Future iterations of H5P content were recommended to consider incorporating elements that correspond with ALLR model to further improve educational outcomes and students' engagement.

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REFERENCES

1. Lajthia, E., Law, M. G., Jorden, J., Haynes, B., Awuonda, M. K., Habib, M., Karodeh, Y. R., & Wingate, L. T. (2024). The impact of critical thinking skills on student pharmacist GPA at a historically Black university. *Currents in Pharmacy Teaching and Learning, 16*(6), 435–444. DOI: 10.1016/j.cptl.2024.04.003
2. Nemati-Vakilabad, R., Mojebi, M. R., Mostafazadeh, P., Jafari, M. J., Kamblash, A. J., Shafaghat, A., Abbasi, A. S., & Mirzaei, A. (2023). Factors associated with the critical thinking ability among nursing students: An exploratory study in Iran. *Nurse Education in Practice, 73*, 103814. DOI: 10.1016/j.nepr.2023.103814
3. Ulger, K. (2018). The Effect of Problem-Based Learning on the Creative Thinking and Critical Thinking Disposition of Students in Visual Arts Education. *Interdisciplinary Journal of Problem-Based Learning, 12*(1). DOI: 10.7771/1541-5015.1649
4. Ennis, R. H. (2018). Critical thinking across the curriculum: A vision (pp. 165-184). DOI: 10.1007/s11245-016-9401-4
5. Facione, P. A. (2011). Critical Thinking : What It Is and Why It Counts. Insight Assessment, XXVIII (ISBN 13: 978-1-891557-07-1), 1–28. Retrieved from https://www.insightassessment.com/CT-Resources/Teaching-For-and-About-Critical-Thinking/Critical-Thinking-What-It-Is-and-Why-It-Counts/Critical-Thinking-What-It-Is-and-Why-It-Counts-PDF
6. Erikson, M. G., & Erikson, M. (2019). Learning outcomes and critical thinking – good intentions in conflict. *Studies in Higher Education, 44*(12), 2293–2303. DOI: 10.1080/03075079.2018.1486813
7. Prayogi, S., Yuanita, L., & Wasis. (2018). Critical inquiry-based learning: A model of learning to promote critical thinking among prospective teachers of physics. *Journal of Turkish Science Education, 15*(1), 43–56.

DOI: 10.12973/tused.10220a
8. Ma, L., & Luo, H. (2021). Chinese pre-service teachers' cognitions about cultivating critical thinking in teaching English as a foreign language. *Asia Pacific Journal of Education, 41*(3), 543–557. DOI: 10.1080/02188791.2020.1793733
9. Directorate of Primary Schools. (2020). Pancasila Student Profile. Retrieved from https://ditpsd.kemdikbud.go.id/hal/profil-pelajar-pancasila
10. Verawati, N. N. S. P., Prayogi, S., Gummah, S., Muliadi, A., & Yusup, M. Y. (2019). The Effect of Conflict-Cognitive Strategy in Inquiry Learning towards Pre-Service Teachers' Critical Thinking Ability. *Jurnal Pendidikan IPA Indonesia, 8*(4). DOI: 10.15294/jpii.v8i4.21002
11. Yan, Z., Chiu, M. M., & Keung Cheng, E. C. (2022). Predicting teachers' formative assessment practices: Teacher personal and contextual factors. *Teaching and Teacher Education, 114*, 103718. https://doi.org/10.1016/j.tate.2022.103718
12. Goertzen, L., Schils, T., & Heeneman, S. (2023). Co-designing formative assessment practices: A collaboration between elementary school teachers and researchers to conceptualize and implement formative assessment as a unified practice. *Teaching and Teacher Education, 134*, 104306. DOI: 10.1016/j.tate.2023.104306
13. Foong, K. W. C., Song, Y. L., Gan, M. J. S., & Lim, A. C. Y. (2024). Making Learning Visible through Formative Assessments in Postgraduate Orthodontic Education. *Seminars in Orthodontics*. DOI: 10.1053/j.sodo.2024.04.009
14. Zhang, H., Ge, S., & Mohd Saad, M. R. Bin. (2024). Formative assessment in K-12 English as a foreign language education: A systematic review. *Heliyon, 10*(10), e31367. DOI: 10.1016/j.heliyon.2024.e31367
15. Lipnevich, A. A., & Panadero, E. (2021). A Review of Feedback Models and Theories: Descriptions, Definitions, and Conclusions. *Frontiers in Education, 6*. DOI: 10.3389/feduc.2021.720195
16. Brookhart, S. M. (2017). How to Give Effective Feedback to Your Students. Alexandria, Virginia: ASCD.
17. Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research, 77*(1), 81–112. DOI: 10.3102/003465430298487
18. Baboolal, S. O., & Singaram, V. S. (2024). Implementation and Impact of an Adapted Digital Perioperative Competency-Building Tool to Enhance Teaching, Learning And Feedback in Postgraduate Competency-Based Medical Education. *Journal of Surgical Education, 81*(5), 722–740. DOI: 10.1016/j.jsurg.2024.01.015
19. Corral, D., & Carpenter, S. K. (2020). Facilitating transfer through incorrect examples and explanatory feedback. *Quarterly Journal of Experimental Psychology, 73*(9), 1340–1359. DOI: 10.1177/1747021820909454
20. Bohan, C., McDowell, C., & Smyth, S. (2022). Does the Immediacy of Feedback Matter in Game-Based Classroom Management? Analysis of the Caught Being Good Game With Adolescent Students. *Journal of Positive Behavior Interventions, 24*(3), 208–221. DOI: 10.1177/10983007211068534
21. Yasaei, H. (2016). The Effect of Immediate vs. Delayed Oral Corrective Feedback on the Writing Accuracy of Iranian Intermediate EFL Learners. *Theory and Practice in Language Studies, 6*(9), 1780. DOI: 10.17507/tpls.0609.09
22. Meyer, J., Jansen, T., Schiller, R., Liebenow, L. W., Steinbach, M., Horbach, A., & Fleckenstein, J. (2024). Using LLMs to bring evidence-based feedback into the classroom: AI-generated feedback increases secondary students' text revision, motivation, and positive emotions. *Computers and Education: Artificial Intelligence, 6*, 100199. DOI: 10.1016/j.caeai.2023.100199
23. Asadi, M., Azizinezhad, M., & Ehsani-Fard, E. (2017). Formative Assessment and Feedback as Predictors of Students' Engagement. *Research in Applied Linguistics, 8*(0), 291–298. DOI: 10.22055/rals.2017.12933
24. Robertson, S., Humphrey, S., & Steele, J. (2019). Using Technology Tools for Formative Assessments. *The Journal of Educators Online, 16*. DOI: 10.9743/JEO.2019.16.2.11
25. Sembey, R., Hoda, R., & Grundy, J. (2024). Emerging technologies in higher education assessment and feedback practices: A systematic literature review. *Journal of Systems and Software, 211*, 111988. DOI: 10.1016/j.jss.2024.111988
26. Kusairi, S. (2020). A web-based formative feedback system using isomorphic items to support Physics learning. *Journal of Technology and Science Education, 10*(1), 117. DOI: 10.3926/jotse.781
27. Laudenbach, M., Brown, D. W., Guo, Z., Ishizaki, S., Reinhart, A., & Weinberg, G. (2024). Visualizing formative feedback in statistics writing: An exploratory study of student motivation using DocuScope Write & Audit. *Assessing Writing, 60*, 100830. DOI: 10.1016/j.asw.2024.100830
28. Rabab'ah, G., & Belgrimet, S. (2020). Postgraduate instructors' formative feedback on EFL students' assignments in email communication: A gender-based study. *The JALT CALL Journal, 16*(2), 85–105. DOI: 10.29140/jaltcall.v16n2.188
29. Cutting, C., & Larkin, K. (2021). The Impact of Weekly Formative Video Feedback on Pre-Service Teachers' Experiences in Online Mathematics Education. *Mathematics Teacher Education and Development, 23*(1), 74–90. Retrieved from https://files.eric.ed.gov/fulltext/EJ1295257.pdf
30. Widodo, W., Sudibyo, E., Suryanti, S., Sari, D. A. P., Inzanah, I., & Setiawan, B. (2020). The Effectiveness of Gadget-Based Interactive Multimedia in Improving Generation Z's Scientific Literacy. *Jurnal Pendidikan IPA Indonesia, 9*(2), 248–256. DOI: 10.15294/jpii.v9i2.23208
31. Suryanti, S., Widodo, W., & Yermiandhoko, Y. (2021). Gadget-Based Interactive Multimedia on Socio-

Scientific Issues to Improve Elementary Students' Science Literacy. *International Journal of Interactive Mobile Technologies (IJIM), 15*(01), 56. DOI: 10.3991/ijim.v15i01.13675
32. Lim, C., Martin, Adnyana, M. A., Achmad, S., & Sutoyo, R. (2023). Online Learning Platform Analysis During COVID-19 Pandemic in Indonesia. *Procedia Computer Science, 227*, 606–613. DOI: 10.1016/j.procs.2023.10.564
33. Rama Devi, S., Subetha, T., Aruna Rao, S. L., & Morampudi, M. K. (2022). Enhanced Learning Outcomes by Interactive Video Content—H5P in Moodle LMS (pp. 189–203). DOI: 10.1007/978-981-19-1012-8_13
34. Carr, W. H., & Barry, A. (2020). H5P as an active learning tool builds content-based critical thinking skills in Biological Sciences and student confidence in problem-based learning. *The Journal of Immunology, 204*(1_Supplement), 222.9. DOI: 10.4049/jimmunol.204.Supp.222.9
35. Jacob, T., & Centofanti, S. (2024). Effectiveness of H5P in improving student learning outcomes in an online tertiary education setting. *Journal of Computing in Higher Education, 36*(2), 469–485. DOI: 10.1007/s12528-023-09361-6
36. Killam, L. A., & Luctkar-Flude, M. (2021). Virtual Simulations to Replace Clinical Hours in a Family Assessment Course: Development Using H5P, Gamification, and Student Co-Creation. *Clinical Simulation in Nursing, 57*, 59–65. DOI: 10.1016/j.ecns.2021.02.008
37. Widodo, W., Suyanto, T., Setyowati, R. R. N., Martini, Sari, D. A. P., & Inzanah. (2018). ALLR learning model. Surabaya: Unesa University Press.
38. Ennis, R. H. (2011). The nature of critical thinking: An outline of critical thinking dispositions and abilities. Retrieved from https://education.illinois.edu/docs/default-source/faculty-documents/robert-ennis/thenatureofcriticalthinking_51711_000.pdf
39. Paul, R., & Elder, L. (2006). Critical thinking: Tools for taking charge of your learning and your life (2nd ed.). Pearson/Prentice Hall.
40. Fisher, A., & Scriven, M. (1997). Critical Thinking: Its definition and assessment. Centre for Research in Critical Thinking.
41. Widodo, W., Sari, D. A. P., Martini, & Suyanto, T. (2019). Strengthening Pre-service Teachers' Character: The application of ALLR Learning Model in Basic Science Subject. *Proceedings of the 1st International Conference on Education Social Sciences and Humanities (ICESSHum 2019)*. DOI: 10.2991/icesshum-19.2019.59
42. Kolb, D. A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Englewood-Cliffs: Prentice-Hall.
43. Black, P., & Wiliam, D. (2010). Inside the Black Box: Raising Standards through Classroom Assessment. *Phi Delta Kappan, 92*(1), 81–90. DOI: 10.1177/003172171009200119
44. Carless, D., & Boud, D. (2018). The development of student feedback literacy: enabling uptake of feedback. *Assessment & Evaluation in Higher Education, 43*(8), 1315–1325. DOI: 10.1080/02602938.2018.1463354
45. H5P. (n.d.). Create, share and reuse interactive HTML5 content in your browser. Retrieved from https://h5p.org/
46. Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). How to design and evaluate research in education. New York: McGraw-Hill.
47. Ghozali, I. (2016). Application of Multivariate Analysis Using the IBM SPSS 23 Program (8th ed.). Semarang: Diponegoro University Publishing Agency.
48. Isnaeni, W., Sujatmiko, Y. A., & Pujiasih, P. (2021). Analysis of the Role of Android-Based Learning Media in Learning Critical Thinking Skills and Scientific Attitude. *Jurnal Pendidikan IPA Indonesia, 10*(4), 607–617. DOI: 10.15294/jpii.v10i4.27597
49. Hart, C., Da Costa, C., D'Souza, D., Kimpton, A., & Ljbusic, J. (2021). Exploring higher education students' critical thinking skills through content analysis. *Thinking Skills and Creativity, 41*, 100877. DOI: 10.1016/j.tsc.2021.100877
50. Yu, Z., Hu, R., Ling, S., Zhuang, J., Chen, Y., Chen, M., & Lin, Y. (2021). Effects of blended versus offline case-centred learning on the academic performance and critical thinking ability of undergraduate nursing students: A cluster randomised controlled trial. *Nurse Education in Practice, 53*, 103080. DOI: 10.1016/j.nepr.2021.103080
51. Mutawa, A. M., Al Muttawa, J. A. K., & Sruthi, S. (2023). The Effectiveness of Using H5P for Undergraduate Students in the Asynchronous Distance Learning Environment. *Applied Sciences, 13*(8), 4983. DOI: 10.3390/app13084983
52. Wu, T.-T., Sari, N. A. R. M., & Huang, Y.-M. (2024). Integrating extended formative assessment in flipped jigsaw learning: Promoting learning engagement and higher-order thinking skills in international business education context. *The International Journal of Management Education, 22*(1), 100930. DOI: 10.1016/j.ijme.2024.100930
53. Broadbent, J., Sharman, S., Panadero, E., & Fuller-Tyszkiewicz, M. (2021). How does self-regulated learning influence formative assessment and summative grade? Comparing online and blended learners. *The Internet and Higher Education, 50*, 100805. DOI: 10.1016/j.iheduc.2021.100805
54. Ma, T., Yuan, H., Yang, X., Li, Y., Yao, J., & Mu, D. (2023). Design of online formative assessment of nursing humanities curriculum during the COVID-19 pandemic: A teaching practice research. *Nurse Education Today, 128*, 105874. DOI: 10.1016/j.nedt.2023.105874
55. He, S., Demmans Epp, C., Chen, F., & Cui, Y. (2024). Examining change in students' self-regulated learning patterns after a formative assessment using process mining techniques. *Computers in Human Behavior, 152*,

108061. DOI: 10.1016/j.chb.2023.108061
56. Wong, H. M., Kwek, D., & Tan, K. (2020). Changing Assessments and the Examination Culture in Singapore: A Review and Analysis of Singapore's Assessment Policies. *Asia Pacific Journal of Education, 40*(4), 433–457. DOI: 10.1080/02188791.2020.1838886
57. Obilor, E. I. (2019). Feedback and Students' Learning. *International Journal of Innovative Education Research, 7*(2), 40–47. Retrieved from https://www.researchgate.net/profile/Esezi-Isaac-Obilor/publication/343609551_Feedback_and_Students'_Learning/links/5f33e743458515b729189e6d/Feedback-and-Students-Learning.pdf
58. McCallum, S., & Milner, M. M. (2021). The effectiveness of formative assessment: student views and staff reflections. *Assessment & Evaluation in Higher Education, 46*(1), 1–16. DOI: 10.1080/02602938.2020.1754761
59. Abel, M., & Bäuml, K.-H. T. (2020). Would you like to learn more? Retrieval practice plus feedback can increase motivation to keep on studying. *Cognition, 201*, 104316. DOI: 10.1016/j.cognition.2020.104316
60. Shute, V. J. (2008). Focus on Formative Feedback. *Review of Educational Research, 78*(1), 153–189. DOI: 10.3102/0034654307313795
61. Duers, L. E., & Brown, N. (2009). An exploration of student nurses' experiences of formative assessment. *Nurse Education Today, 29*(6), 654–659. DOI: 10.1016/j.nedt.2009.02.007
62. Mackintosh-Franklin, D. C. (2021). An evaluation of formative feedback and its impact on undergraduate student nurse academic achievement. *Nurse Education in Practice, 50*, 102930. DOI: 10.1016/j.nepr.2020.102930
63. Barkela, V., Schmitt, L., & Leuchter, M. (2023). The impact of cognitive and motivational resources on engagement with automated formative feedback. *Contemporary Educational Psychology, 75*, 102234. DOI: 10.1016/j.cedpsych.2023.102234
64. Hansen, G., & Ringdal, R. (2018). Formative assessment as a future step in maintaining the mastery-approach and performance-avoidance goal stability. *Studies in Educational Evaluation, 56*, 59–70. DOI: 10.1016/j.stue-duc.2017.11.005
65. Sonnadara, R., McQueen, S., Mironova, P., Safir, O., Nousiainen, M., Ferguson, P., Alman, B., Kraemer, W., & Reznick, R. (2013). Reflections on current methods for evaluating skills during joint replacement surgery. *The Bone & Joint Journal, 95-B*(11), 1445–1449. DOI: 10.1302/0301-620X.95B11.30732
66. Morris, R., Perry, T., & Wardle, L. (2021). Formative assessment and feedback for learning in higher education: A systematic review. *Review of Education, 9*(3). DOI: 10.1002/rev3.3292
67. Santrock, J. W. (2011). Educational Phycology – Fifth Edition. New York: McGraw-Hill.
68. Ozkan, G., & Topsakal, U. U. (2020). Determining Students' Conceptual Understandings of Physics Concepts. *Shanlax International Journal of Education, 8*(3), 1–5. DOI: 10.34293/education.v8i3.2908
69. Barmby, P., D., B., & Thompson, L. (2014). Understanding and Enriching Problem Solving in Primary Mathematics. London: Routledge.
70. Dewi, S. Z., & Ibrahim, T. (2019). The importance of understanding concepts to overcome misconceptions in science learning materials in elementary schools. *UNIGA Journal of Education, 13*(1), 130–136. DOI: 10.52434/jp.v13i1.823
71. Sands, D., Parker, M., Hedgeland, H., Jordan, S., & Galloway, R. (2018). Using concept inventories to measure understanding. *Higher Education Pedagogies, 3*(1), 173–182. DOI: 10.1080/23752696.2018.1433546
72. Anggraini, L., Maison, & Syaiful. (2022). Attitude and Understanding of Concepts: It's Influence in Science Learning. *Journal of Education Research and Evaluation, 6*(3), 423–430. DOI: 10.23887/jere.v6i3.45991
73. Yuliyanti, N. (2019). Students' Ability to Understand Mathematical Concepts Using a Realistic Mathematics Learning Approach. *Rafflesia Journal of Mathematics Education, 4*(1). Retrieved from https://ejournal.unib.ac.id/index.php/jpmr
74. Radulović, L., & Stančić, M. (2017). What is needed to develop critical thinking in schools? *CEPS Journal, 7*(3), 9–25. Retrieved from https://files.eric.ed.gov/fulltext/EJ1156618.pdf
75. Raeisoon, M. R., Nadooshan, S. G., Eslahi, M., & Mohammadi, Y. (2017). Comparing Skills of Critical Thinking and Happiness among Students of Faculty of Medial Sciences and other Universities of Ghaen. *Future Of Medical Education Journal, 7*(1), 3–7. DOI: 10.22038/FMEJ.2017.8511
76. Zamirinejad, S., Piltan, M., Haghshenas, M., Tabarraei, Y., & Akaberi, A. (2014). Prediction of happiness based on spiritual intelligence. *Journal of Sabzevar University of Medical Sciences, 20*(5), 773–781. Retrieved from https://jsums.medsab.ac.ir/article_395.html?lang=en
77. Eid, D., Abdelrazek, F., & Adam, S. (2024). Students Satisfaction with Blended Learning and their Learning Style in Relation to Academic Achievement at Faculty of Nursing in Suez Canal University. *Trends in Nursing and Health Care Journal, 8*(1), 246–268. DOI: 10.21608/tnhcj.2024.268864.1048
78. Saffari, M., Sanaeinasab, H., Rashidi, J. H., Purtaghi, G. H., & Pakpour, A. (2014). Happiness, Self-efficacy and Academic Achievement among Students of Baqiyatallah University of Medical Sciences. *Journal of Medical Education Development, 7*(13), 45–56. Retrieved from https://taromh.zums.ac.ir/edujournal/article-1-185-fa.html
79. Alsadoon, E., Alkhawajah, A., & Suhaim, A. Bin. (2022). Effects of a Gamified Learning Environment on Students' Achievement, Motivations, and Satisfaction. *Heliyon, 8*(8), e10249. DOI: 10.1016/j.heliyon.2022.e10249

80. Polat, M. (2017). Investigation of critical thinking tendencies and creativity levels of classroom teachers according to several variables. Adiyaman: Adiyaman University.
81. Yuan, R. (2023). The other side of the coin: A socio-cultural analysis of pre-service language teachers' learning to teach critical thinking. *Thinking Skills and Creativity, 48*, 101265. DOI: 10.1016/j.tsc.2023.101265
82. Davies, M. J., & Willing, L. (2023). An examination of teachers' beliefs about critical thinking in New Zealand high schools. *Thinking Skills and Creativity, 48*, 101280. DOI: 10.1016/j.tsc.2023.101280
83. Yang, Y.-F., & Tsai, C.-C. (2010). Conceptions of and approaches to learning through online peer assessment. *Learning and Instruction, 20*(1), 72–83. DOI: 10.1016/j.learninstruc.2009.01.003
84. Wicaksono, J. A., Setiarini, R. B., Ikeda, O., & Novawan, A. (2021). The Use of H5P in Teaching English. *Proceedings of the First International Conference on Social Science, Humanity, and Public Health (ICOSHIP 2020)*. DOI: 10.2991/assehr.k.210101.049

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