RESEARCH ARTICLE

Student metacognition in online learning using website hyperlink facilities on Microsoft Team's platform

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Abstract: Without the ability to analyze their own learning (metacognition), students can find it difficult to manage their educational journey. The good news is, future learning environments on online platforms offer innovative ways to develop these skills, even for those who are digital natives. This study aims to ascertain the effectiveness of online learning by using a website hyperlink-based teaching and learning scenario, especially using the Microsoft Teams platform towards students' metacognition during online learning. Both metacognition knowledge and awareness (regulation), representing the metacognition, were checked. Coordination systems in learning biology were the chosen topics to be taught in quasi-experimental research using a pretest-posttest nonequivalent control group design. Two classes were selected purposely based on the normality and homogeneity test to have the controlled and experimental classes. We examined the metacognitive knowledge and awareness using tests and questionnaires. We checked the effectiveness of the web hyperlink-based media on students' metacognition knowledge and awareness using MANOVA Regression analysis and N-Gain scores. Our developed web hyperlink-based media has significantly enhanced students' cognitive knowledge and awareness.

Keywords: hyperlink website; metacognitive awareness; metacognitive knowledge; online learning

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Introduction

Learning in the 21st-century should address the challenge of preparing learners to live and face the new world paradigm. Such a knowledge transfer process must endorse learners with appropriate knowledge and skills needed in the societal and technological disruption era. Targeting metacognition outcomes in a cross-disciplinary approach and *IoT* adoption into the subject-specific teaching and learning process is needed to facilitate learners with knowledge and skills that critically underpin their capacity to live together in the 5.0 society (Sahoo, 2022). Teaching and learning activities should then be designed specifically to engage with scenarios emphasizing meaningful learning and metacognition rather than focusing on rote memorization and lower-order cognitive output (Stanton et.al., 2021).

Indeed, metacognition is one of the important learning outcomes (Marantika, 2021). Metacognition implies a stage of self-organized learning. It is related to the ability of students as individual learners to plan, monitor, and evaluate during their learning activities (Tsamago & Bayaga, 2023). Metacognition allows students to organize the available knowledge and information in their thinking world and perform a more efficient learning process to make effective learning (Tsai et al., 2022). Students with poor metacognitive ability will not be able to organize the tasks at hand through planning, monitoring, and evaluating compared to metacognition-bearing students. Metacognition is constructed by two main dimensions, i.e., metacognitive knowledge and awareness/regulation (Ibabe & Jauregizar, 2010). These two dimensions are critical to helping educators assess and evaluate the learning outcome during the conducted knowledge transfer process. Metacognitive knowledge can inform the extent of important learning concepts the learner organizes, whereas metacognitive awareness measurement can reveal the degree of self-regulation performance of the student (Cera, et. al., 2014).

Moreover, to many offline learning strategies in metacognition enhancement, metacognitive skills and awareness can be enhanced through online learning platforms. Metacognitive strategies can be used in online learning and still have the power to affect student's learning performance (Amien & Hidayatullah,

2023). Since generations now and in the future are understood to be digitally native, the discussion about effective learning to enhance metacognition would deal with teaching and learning scenarios aided by technological-based approaches (Handayani et.al., 2023). Here in this paper, we employed discovery learning model with a website hyperlinks facilities involvement in the Microsoft Teams platform to facilitate learning biological coordination system and examined the effectiveness of such an online platform in enhancing metacognition in terms of metacognitive knowledge and awareness. Microsoft Teams, as a part of the Microsoft 365 software, facilitates an online interface for collaborative activities (Tan et. al., 2022). The discovery Learning model, when integrated with online platforms like Microsoft Teams, enhances student engagement and cognitive outcomes (Khairuddin et al., 2021). This model encourages active learning by stimulating students to explore, problem-solve, and process information, leading to long-lasting memory retention. Implementing the learning through online platforms can significantly improve cognitive learning outcomes in subjects like science (Ma & Buechler, 2021). The interactive online methods not only boost learning participation but also increase metacognitive knowledge and awareness, ultimately enhancing students' overall learning experience and outcomes. Some direct and indirect learning features include discussion forums, Kahoot, e-book links, and a website hyperlink menu that can support online teaching and learning to target metacognitive knowledge and awareness of students. The hyperlink menu in the platform helps organize information needed during the teaching and learning process. It supports metacognition enhancement by allowing students to access guidance and feedback through informative search queries (Sternad et. al., 2022). In addition, the website hyperlink's applicability for mobile phones and laptops gives the student easy access to the provided learning materials. This research is crucial because online learning is widely used nowadays, yet there is limited information on the effectiveness of each platform in enhancing metacognition and awareness. One platform that has not been extensively studied for its effectiveness is the hyperlink method in Microsoft Teams, making this research significant. Furthermore, this research is expected to serve as a reference for future research on the effectiveness of online learning in improving students' metacognition and awareness.

Methods

Research design

This research followed a quantitative research paradigm by performing a Quasi-experimental research approach and using a pretest-posttest non-equivalent control group design. This research's main objective was to examine the effectiveness of our developed online learning scenario that engages website-hyperlink features on the Microsoft Teams platform towards metacognitive knowledge and awareness. We confined our study to researching high school students using controlled and experiment classes purposefully selected before the data collection to whom we implemented our subject-specific lesson scenario developed preceding the overall research.

Population and samples

Since metacognition is strongly related to self-regulation performance, we targeted the student in a formal-operational stage of Piaget's cognitive development classification. We researched senior high school science students of SMA NEGERI 1 TERAS, Indonesia, representing students in the formal-operational stage. The total number of science classes in the high school is four, with 141 student population. After a series of normality and homogeneity checks towards the portfolio accomplishment of all classes, we sampled two classes for the control class (XI MIPA 3 with a total of 35 students) and the controlled class (XI MIPA 4 with 36 students).

Source and collection of data

Our research stands mainly on the primary data. Student participants were the main data source showing the extent of metacognitive knowledge and awareness. The data were collected using appropriate data collection procedures according to the goals and type of the data. Our main research goals were to examine metacognitive knowledge and awareness. We used a cognitive test instrument to assess the participants' metacognitive knowledge achievement. Such evaluation instruments were designed to fulfill the higher-order thinking skill (C4-C6) to reveal all aspects of metacognitive knowledge, including declarative, procedural, and conditional knowledge, and given as pre and post-test. We conducted simple interviews using a five-scaled Likert questionnaire to examine students' cognitive awareness. Both the test and questionnaire were administered to all participants in all selected classes.

Data Analysis

We attempted to reveal and examine the impact of teaching and learning using website-hyperlink in the MS Teams platform. We proposed three major research goals and addressed six hypotheses to ascertain

the impact of our learning scenario on the independent variables. After performing a series of data collection resulting in normally distributed and homogenous data, we employed a parametric data analysis using the MANOVA technique of SPSS 25 to ascertain the impact of website hyperlinks in the MS Teams platform on students' metacognitive knowledge and awareness. We used regression analysis to determine the impact of website hyperlinks in the MS Teams platform on all aspects of our dependent variables. We also employed N-Gain tests to reveal the effectiveness of using a website in the MS Teams platform on students' metacognitive knowledge and awareness.

Results and Discussion

We conducted normality and homogeneity checks to ensure that the data gained from the instrument can run in a parametric analysis. The normality checks of the data gained from metacognitive knowledge, awareness, and cognitive tests resulted in values less than the *p-value* (0.05) (can be seen in Table 1). The normality test results from both controlled and experiment classes showed that all instruments resulted in normally distributed data and were appropriately eligible for MANOVA analysis.

Table 1. Normality test results of the data resulted from the applied research instruments

Research Instruments	Form	Class		Decision
		Experiments	Control	
Metacognitive knowledge	Soal	0.601	0.338	Normal
Metacognitive awareness	Questionnaire	0.314	0.08	Normal
Cognitive test	Pretest	0.195	0.122	Normal
	Posttest	0.068	0.064	Normal

The homogeneity checks of the data gained from metacognitive knowledge and awareness and cognitive test resulted in Lavene's statistic value being less than the *sig.* value (0.05). The results of the homogeneity check showed that all instruments resulted in homogenous data (Table 2) and, therefore, are applicable for MANOVA analysis.

Table 2. Homogeneity test of the data resulted from the applied research instruments

Instrument	Form	Levene's Statistic	Sig. Value	Decision
Metacognitive Knowledge	Test	0.343	0.560	Homogenous
Metacognitive awareness	Questionnaire	1.122	0.293	Homogenous
Cognitive test	Test	0.337	0.798	Homogenous

The hypothesis tests

We proposed six hypotheses to be addressed. Three first hypotheses were proposed to reveal the impact of website hyperlinks in the MS Teams platform on students' metacognitive knowledge and awareness, both in a separate and concurrent test. The 4th-5th hypotheses were related to ascertaining the extent of the impact of website hyperlinks in the MS Teams platform on students' metacognitive knowledge and awareness of the regression analysis. The last hypothesis is related to the N gain score. 1st Hypothesis was about testing the impact of website hyperlinks in the MS Teams platform on students' metacognitive knowledge. The result of the MANOVA test was 0.00 (less than 0.06). The Null hypothesis (H_0) was declined, showing that website hyperlinks in the MS Teams platform impacted students' metacognitive knowledge.

The 2nd Hypothesis was proposed to test the impact of website hyperlinks in the MS Teams platform on students' metacognitive awareness. The result of the MANOVA test was 0.00 (less than 0.05). The Null hypothesis (H_0) was declined, showing that website hyperlinks in the MS Teams platform impacted students' metacognitive awareness.

The 3rd hypothesis was proposed to test the impact of website hyperlinks in the MS Teams platform on students' metacognitive knowledge and awareness. All results are given in the Table 3. The result of the MANOVA test was 0.00 (less than 0.05). The Null hypothesis (H0) was declined, showing that website hyperlinks in the MS Teams platform affected both students' metacognitive knowledge and awareness concurrently.

Table 3. MANOVA test Result

Test	Sig.	p Value	Decisions
Pillai's Trace	0.00	Sig < 0.05	H0 declined
Wilks' Lambda	0.00	Sig < 0.05	H0 declined
Hotelling's Trace	0.00	Sig < 0.05	H0 declined
Roy's Largest Root	0.00	Sig < 0.05	H0 declined

The 4th hypothesis was proposed to determine the extent of the effect of Hyperlink Website-based learning media on students' metacognitive knowledge in all aspects, namely declarative, procedural, and conditional knowledge. The hypothesis was tested by looking at the effective contribution from the table of regression analysis (Table 4).

Tabel 4. Regression analysis for all aspects of metacognitive knowledge

Aspects	Beta coefficient	Correlation Coefficient	Effective contribution
Declarative knowledge	0.431	0.473	20.38%
Procedural knowledge	0.343	0.389	13.34%
Conditional knowledge	0.109	0.053	0.58%

Table 4 shows the results of regression tests on all aspects of metacognitive knowledge. Effective contribution values tell the strong contribution of each metacognitive knowledge aspect after implementing website hyperlinks in the MS Teams platform during the learning process. Table 4 shows that declarative knowledge is highly affected after implementing online learning with the MS Teams platform, followed by procedural and conditional knowledge.

The 5th hypothesis was proposed to determine the extent of the effect of our designed online learning on students' metacognitive awareness in all aspects, namely planning, debugging process, information management strategy, metacognitive monitoring capacity, and evaluation. The hypothesis was tested by looking at the effective contribution from the table of regression analysis. Table 5 shows the results of regression tests on all aspects of metacognitive awareness. Effective contribution values tell the strong contribution of each metacognitive knowledge aspect after implementing website hyperlinks in the MS Teams platform during the learning process. Table 5 shows that our online learning scenario mostly enhances students' metacognitive monitoring capacity and information management strategy.

Table 5. Regression analysis for five aspects of metacognitive awareness

Aspects	Beta coefficient	Correlation coefficient	Effective contribution
Planning	0.194	0.358	6.94%
Debugging process	0.175	0.295	5.17%
Information Management Strategy	0.331	0.503	16.65%
Metacognitive monitoring capacity	0.399	0.445	17.74%
Evaluation	0.029	0.003	0.01%

The 6th hypothesis was proposed to scrutinize the effectivity of our designed online learning on students' metacognitive knowledge and awareness. We stand on the *N-Gain* results (summarized in Table 6) to show the effectiveness of applying website hyperlinks in the MS Teams platform on students' metacognitive knowledge and awareness between controlled and experiment classes.

Tabel 6. N-Gain score in the controlled and experiment classes

Aspects	Classis	N-Gain Score	Category	N-Gain (%)	Interpretation
Cognitive test	Controlled	0.27	Low	26.59	Ineffective
	Experimental	0.58	Moderate	58.41	Fairly effective

Based on Table 6 above, the experimental class has a higher *N-Gain* score than the controlled class. The *N-Gain* scores of the two classes tell the effectiveness of applying teaching and learning using website hyperlinks in the MS Teams platform on students' metacognitive knowledge and awareness. Students' metacognitive knowledge and awareness are enhanced after implementing online teaching and learning using website hyperlinks in the MS Teams platform.

Online learning using website hyperlink in the MS platform enhances student metacognitive knowledge

The transformation from offline to online during the pandemic created a new habit of learning characterized by an indirect interaction between educators and learners (Fatima et al., 2023). Such indirect interaction may face obstacles since the lack of physical interaction is a major disadvantage of online education, preventing effective direct communication between educators and students. Several affective domains of learning outcome may also be difficult to measure, making affective assessments should be specifically designed to address the challenge of the changing platform (Ansari & Khan, 2020). However, despite the weaknesses, online learning can provide several advantages. Online learning facilitates students to have full control over their learning since students can learn at their own speed with unlimited repetition (Ivan, 2013). In addition, many online sources can be good learning providers for unlimited data, information, and knowledge, making learning easier as all materials are in a hand (Xhaferi & Xhaferi, 2020; Shatri, 2020; Hoq 2020).

Despite the accessibility of data, information, and knowledge, online sources may be too voluminous for the learner to organize easily. The role of the teacher in facilitating an effective learning process while still emphasizing the critical affective domain of learning is still needed. It is important to enhance the awareness of learning in a well-organized structure (Huang, 2018; Madsgaard et al., 2022; Jia & Tu, 2024). Metacognition enhancement during learning is needed to help learners follow a more structured pattern during the learning process. Preparing teaching and learning processes enhancing students' metacognition aided by IoT facilitation is one of the solutions for learning preparation generation in the 4.0. revolution and 5.0 society.

Microsoft Teams (MS Teams) is a workspace platform Microsoft Corp. provides for real-time collaboration and communication (Tan et al., 2022; Deželak et al., 2023; Ma & Buechler, 2021). Many available features are applicable for online learning and metacognitive enhancement. We prepared an online teaching-and-learning scenario in the biological coordination system to enhance metacognitive knowledge and awareness using the website hyperlink menu in the MS Teams platform. The result of the Manova test showed that website hyperlinks in the MS Teams platform affect students' metacognitive knowledge with a moderate level of influence. Such online learning methods also improved all aspects of metacognitive knowledge, particularly in declarative knowledge. Our teaching and learning scenario used the hyperlink feature to help the teacher direct the learning process to facilitate students to access learning materials and media, videos, pictures, information, and an appropriate self-assessment on a topic of coordination system in a more systematic manner. The learning characteristics of the gadget-dependent generation (Gen Z) natively familiar with computerized technology are addressed and fulfilled (Tafonao et. al., 2020; Yoanita & Primasanti 2022). Students are highly attracted and enthusiastic to learn since the learning platform provides interesting, well-structured learning material that helps them learn more effectively. Declarative knowledge is then enhanced since students are facilitated with sufficient learning material that provides them with sufficient factual data, information, and knowledge the learner needs for further processing or use in critical thinking related to the topic (Wilis, et. al., 2023; Saks et al., 2021; Khairuddin et al., 2021). Indeed, declarative knowledge enhancement in metacognition is important to underline further learning outcome achievement. In this research, the cognitive test results also indicated the improvement of metacognitive knowledge achievement in the experiment class. The website hyperlink facilities in the platform help students to understand many difficult concepts in the coordination system easily and clearly (Afifah et. al., 2021; Chansanam et al., 2021; Simamora et al., 2020). Therefore, they just performed an effective learning process.

The effectiveness of our online teaching and learning platform is also enhanced with the discovery learning model engaged in the learning scenario. Progressive syntaxes in the discovery models relevantly facilitates the cognitive knowledge development (Nusantari et. al., 2023; Peng et al., 2019; Hasairin et al., 2023). The website hyperlink facilities in the platform allow students during the first steps of the teaching and learning process (orientation). The orientation steps in the discovery learning direct the students to make observations on several cases in biological coordination system, pictures, and videos and allows students to have positive first impressions which then build their enthusiasm for learning. By this syntax, metacognitive awareness can also be enhanced concurrently. During the orientation process, students also determined to formulate questions and comments to be addressed in the hypothesis generation syntax. In the hypothesis generation steps, students are urged to search for data, information, and knowledge on the platform. Therefore, students are involved in the active learning process by which procedural knowledge in metacognitive knowledge is corroborated. The hypothesis testing in the discovery models allows students to use the declaration and procedural knowledge to build their conditional knowledge. The overall syntaxes of the discovery model used in the developed online platform are considered meaningful in metacognitive knowledge reinforcement.

The effect of the website hyperlinks in the MS Teams platform towards metacognitive awareness

Metacognitive awareness is an important learning outcome that is closely related to self-regulation and efficacy possessed by the student. Metacognitive awareness can be enhanced by implementing active learning in the student-centered learning paradigm. Metacognitive awareness consists of five aspects: planning, debugging process, information management strategy, metacognitive monitoring capacity, and evaluation (Sandars & Homer, 2010; Kallio et al., 2018; Ubaidullah et al., 2021; Hota et al., 2022; Jain et al., 2017). The website hyperlinks used in the MS Teams platform have significantly affected the cognitive awareness of the students. After a series of implementations, our online learning scenario mostly enhances students' metacognitive monitoring capacity and information management strategy of metacognitive awareness.

Examples of cases in biological coordination systems, pictures, and videos in the website hyperlinks provide students with interesting learning materials, allowing students to have positive impressions and enthusiasm for learning. Such attractive learning materials are also displayed in a well-organized feature, enhancing metacognitive awareness's information management strategy. The availability of well-organized data, information, and knowledge is also helpful for further learning processes, including analysis and evaluation. The organized learning materials facilitate students to possess self-regulation and efficacy to learn (Alkan, 2020; Guven & Babayigit, 2020). Therefore, the metacognitive monitoring is measured better in the experimental class compared to the controlled class.

Conclusion

Website-hyperlinks features in the online teaching scenario on the MS Teams platform have effectively enhanced student metacognitive knowledge and awareness. The well-designed data, information, and knowledge as learning materials have enabled the website hyperlink in the declaration and procedural aspects reinforcement in the metacognitive knowledge. Systematics' arrangement of learning materials also facilitates information management strategy and metacognitive monitoring aspects in metacognitive awareness.

Conflicts of Interest

The author has no conflicts of interest in this paper.

Author Contributions

P. Karyanto: methodology, validation, analysis, review, and editing. **A. N. Rohman:** writing draft.

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