

Effectiveness of Interactive Crossword Game Education on Adolescents' Knowledge Level about Prevention of Sexually Transmitted Infections

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Abstract:

Adolescence (10-24 years) is a critical developmental period with significant physical and psychological changes, placing teens at high risk for sexually transmitted infections (STIs). Interactive crossword puzzle games offer an engaging alternative to traditional health education methods. This quasi-experimental study with a nonequivalent control group design examined the effectiveness of interactive crossword puzzles on adolescents' STI prevention knowledge. Using stratified random sampling, 102 students (grades X–XII) were recruited from SMAN 8 Jambi City (intervention group, n=51) and SMAN 5 Jambi City (control group, n=51). The intervention group received a single 90-minute session combining STI education (30 minutes) and crossword puzzle activities (60 minutes), while the control group received conventional lectures of equal duration. Knowledge was assessed using a validated 25-item questionnaire before and immediately after the intervention. Mann-Whitney test analysis revealed no significant difference between groups pre-intervention ($p=0.959$), but a statistically significant improvement post-intervention ($p=0.001$). The intervention group showed a substantial mean score increase from 19.71 to 22.22, while the control group showed minimal change from 20.02 to 20.49. The crossword puzzle method proved significantly more effective than conventional lectures for enhancing adolescents' STI knowledge, with the intervention group achieving 100% knowledge classification as "good" compared to 90.2% in the control group. Interactive crossword game education is a highly effective, innovative, and applicable method to improve adolescents' knowledge of sexually transmitted infections, with superior effectiveness compared to conventional education methods.

Keywords: adolescence, crossword, knowledge, Sexually Transmitted Infections

Submitted: 18 June 2025, reviewed: 29 August 2025, revised: 01 July 2026, accepted: 02 July 2026, published: 31 July 2026

INTRODUCTION

The adolescent period, which spans ages 10 to 24, is a critical transition to adulthood, characterized by significant changes in physical, intellectual, and psychological domains ([Ariyanti et al., 2019](#)). According to the Regulation of the Minister of Health of the Republic of Indonesia, individuals aged 10 to 18 are classified as adolescents ([Kementerian Kesehatan Republik Indonesia, 2024](#)). This period of life between childhood and adulthood is characterized by various developments in identity formation, including the emergence of secondary sexual characteristics and the achievement of sexual maturity ([Emilda, 2021](#)).

One of the main challenges adolescents face is building relationships with others and adapting to their environment. Failure to get through this phase can lead adolescents to engage in risky behaviors and violate social norms ([Theresia et al., 2020](#)). The lack of readiness of adolescents in facing these changes can trigger various harmful behaviors, such as delinquency, drug abuse, sexually transmitted infections (STIs), including HIV/AIDS, unplanned pregnancies, abortion, free sexual intercourse, and other reproductive health problems ([Susilowati et al., 2020](#)).

Sexually transmitted infections (STIs) have become a serious global health problem. Every day,

more than one million cases of STIs occur around the world, with more than 499 million new cases estimated to occur each year ([WHO, n.d.](#)). Adolescents and young adults (15-24 years old) have the highest risk of contracting STIs ([Hairuddin et al., 2022](#)). Data from the 2017 Indonesian Demographic Health Survey (IDHS) show that the 15-19 age group is the most likely to initiate sexual intercourse for the first time, with a higher ratio of males than females (74%:59%) ([BKKBN, 2018](#)).

The situation in Indonesia is alarming, with Indonesia ranked as the fifth most STI-prone country in Asia, with 140,803 STI cases treated in 430 STI services in 2018 ([Hairuddin et al., 2022](#)). At the regional level, Jambi Province recorded 177 STI cases in 2021, with Jambi City having the highest case rate ([Badan Pusat Statistik Provinsi Jambi, 2022](#)). Data from the Jambi City Health Office shows that there were 85 HIV-positive people in 2023, with the dominance of cases in men (78 cases) compared to women (7 cases).

Factors affecting adolescent reproductive health are very complex, including communication with parents on reproductive health topics, level of education and knowledge, living environment conditions, early sexual behavior with multiple partners without contraceptive use, peer influence, media exposure, access to reproductive health services, economic status, as well as adolescents' views, attitudes, and beliefs towards reproductive health ([Rahmawati et al., 2023](#)). In this context, health education in schools plays a strategic role in encouraging adolescents to actively seek health information and make wise decisions ([Ajani, 2023](#)).

Effective health education in schools can equip adolescents with the knowledge and skills to manage health information wisely, including recognizing reliable sources and making health decisions based on valid evidence ([Utami & Thohir, 2022](#)). To achieve maximum effectiveness, the educational process must be able to develop individuals who are ready to face challenges and rapid changes in the world, with teachers needing to choose appropriate methods and media in the learning process ([Hidayat et al., 2020](#)).

Various learning media can be used in health education, including animated videos, presentations, talk shows, lectures, infographics, social media, e-books, field trips, projects or simulations, and digital platforms ([Wahid et al., 2024](#)). Research shows that high school students prefer interactive learning methods such as projects or simulations, field trips, and talk shows because they provide practical experience. One of the innovative media that can be used is crossword puzzles (TTS), which has been proven to help reduce the boredom felt by students during the learning process ([Hidayat et al., 2020](#)).

Crossword puzzles as educational game-based learning media have simple but effective characteristics, especially for material that is abstract and has many terms ([As'ari, A. S. & Raharjo., 2019](#)). TTS media can make students more enthusiastic in the learning process because they can learn while playing, so that the learning atmosphere becomes more fun and the material is easier to remember ([Dewanti et al., 2019](#)). Research conducted by Angelique showed that the use of TTS adapted to reproductive health material provided a significant increase with an increase in the average score from 32.34 in the pre-test to 58.30 in the post-test ([Angelique et al., 2023](#)).

Based on the results of interviews conducted at SMAN 8 Jambi City, it was found that 7 out of 10 students did not understand sexually transmitted diseases and only knew information related to STIs through social media. They also stated that they had never received education about risky behaviors that could transmit sexually transmitted diseases. Further observation showed that there were no community nurses or health workers specifically involved in the school, and the School Health Unit (UKS) available was still passive and not optimally utilized as a means of health promotion and education.

This condition creates a significant gap between adolescents' need for accurate reproductive health information and the availability of effective and engaging educational programs. The limitations of conventional educational methods and the lack of health workers in the school environment require the development of alternative methods that can reach students effectively. Therefore, innovation is needed in the delivery of reproductive health education that can increase adolescents' knowledge about STI prevention through an interactive and fun approach.

METHODS

This study used a quasi-experimental design with a nonequivalent control group, involving two groups that received a pretest and a posttest. This research was conducted in February 2025. The study was conducted at two public senior high schools in Jambi City, Indonesia: SMAN 8 Jambi City (intervention group) and SMAN 5 Jambi City (control group). Both schools were selected due to their comparable student demographics and socioeconomic characteristics.

The population consisted of students from SMAN 8 Jambi City, totaling 1,340 students. Using the Slovin formula with a 0.1 error rate, the required sample size is calculated as 93 students. With an anticipated 10% dropout rate, the total sample size increased to 102 respondents, comprising 51 students in the intervention group from SMAN 8 Jambi City and 51 students in the control group from SMAN 5 Jambi City, all from grades X, XI, and XII. Sampling conducted using a stratified random sampling technique, proportionately distributed across grade levels: Grade X (n=27), Grade XI (n=45), and Grade XII (n=30).

The inclusion criteria for this study are: students in grades X, XI, and XII at SMAN 8 and SMAN 5 Jambi City in academic year 2024-2025, adolescents aged 10-18 years, currently enrolled in SMAN 8 and SMAN 5 Jambi City, cooperative and able to participate fully during the research period, and signed an informed consent form prior to participation. The exclusion criteria in this study are: Incomplete questionnaire responses, and participants who were ill during the research period.

The intervention group received a single 90-minute educational session consisting of two phases: (1) structured STI education delivered over 30 minutes, covering definition and basic concepts of STI, causes, symptoms and signs, risk factors, impacts, and prevention and management strategies; (2) interactive crossword puzzle activity for 60 minutes, where students divided into teams to collaboratively work on a crossword puzzle containing 19 questions about STI prevention. The instructor read each question aloud, and teams took turns answering by filling in words according to the number of squares. If a team could not answer, the turn passed to another team. The control group received conventional lecture-based education on STI prevention with identical material and duration (90 minutes) as the intervention group, but without the interactive crossword puzzle component.

Knowledge was assessed using a validated 25-item questionnaire adopted from Rizqa Haerani Saenong's research. The questionnaire utilized a Guttman scale measurement (correct answer = 1, incorrect answer = 0). The instrument demonstrated adequate validity (r-values > 0.338 for all items) and reliability (Cronbach's Alpha = 0.774). Adolescents' knowledge levels were categorized as either "good" (score > 70%) or "poor" (score ≤ 70%).

Data collection began with informed consent procedures, where researchers explained the purpose and benefits of the research to respondents. After all respondents agreed to and signed the informed consent form, a pre-test was administered using the STI knowledge questionnaire to determine students' baseline knowledge before receiving the intervention. Following the respective intervention (either a crossword puzzle education or a conventional lecture), the post-test was administered immediately afterward to minimize memory decay and external influences.

After the post-test, researchers processed the data through several stages: coding, tabulating, editing, cleaning, and describing. The data were analyzed using IBM SPSS version 25 with descriptive statistics to summarize participant characteristics and knowledge distribution, and the Mann-Whitney test (non-parametric) to examine differences in knowledge scores between the intervention and control groups at pre-test and post-test time points. A significance level of $\alpha = 0.05$ (95% confidence level) was used, with $p < 0.05$ indicating statistical significance.

This study received ethical clearance from the Health Research Ethics Committee of Jambi University with approval number 830/UN21.8/PT.01.04/2025. Researchers provided detailed and transparent explanations to all prospective participants regarding the research purpose, procedural stages, potential benefits, and risks. All participants provided written informed consent prior to enrollment. Participant identity was protected through coding; respondents were identified only by numerical codes in all reports and publications. All information obtained from participants was kept confidential and reported only as research data, without disclosing participant identities or other

confidential information. All respondents were treated fairly and equally without discrimination throughout the research period.

RESULTS

Table 1. Frequency Distribution Of Respondents' Knowledge Variables (N=102)

Characteristic		Knowledge Level			
		Intervention Group		Control Group	
		n	%	n	%
Age	15 years	2	3.9	4	7.8
	16 years	19	37.3	20	39.2
	17 years	23	45.1	20	39.2
	18 years	7	13.7	7	13.7
Gender	Male	21	41.2	23	45.1
	Female	30	58.8	28	54.9
Grade	X	13	25.5	14	27.5
	XI	23	45.1	22	43.1
	XII	15	29.4	15	29.4
Living Situation	With parents	46	90.2	44	86.3
	Alone	1	2.0	2	3.9
	With siblings	4	7.8	5	9.8
Information Source	Internet	12	23.1	12	23.5
	Parents	4	7.8	6	11.8
	School	35	68.6	33	64.7

This study involved 102 respondents, equally divided into the intervention and control groups (51 students each). The age distribution in both groups was relatively similar, with the majority of respondents aged 16–17 years. Most respondents were female, in 11th grade, living with their parents, and obtained information about sexually transmitted infections primarily from school. This similar distribution of baseline characteristics indicates that the two groups were quite comparable before the treatment.

Table 2. Frequency Distribution Of Respondents' Knowledge Variables (N=102)

		Knowledge Level				Total	
		Poor		Good			
		n	%	n	%	n	%
Pre Test	Intervention	8	15.7	43	84.3	51	100
	Control	6	11.8	45	88.2	51	100
Post Test	Intervention	0	0	51	100	51	100
	Control	5	9.8	46	90.2	51	100

According to [Table 2](#), the intervention group presents a significant increase in knowledge. Before the intervention (pre-test), eight respondents (15.7%) were in the poor knowledge category, and 43 respondents (84.3%) were in the good category. After the intervention (post-test), all respondents (100%) were in the good knowledge category. This shows that the intervention provided is very effective in improving respondents' knowledge.

Meanwhile, in the control group, the increase in knowledge was not very significant. In the pre-test, six respondents (11.8%) were in the poor knowledge category, and 45 respondents (88.2%) were in the good category. After the post-test, the number of respondents with poor knowledge decreased to 5 (9.8%), while those in the good category increased to 46 (90.2%). This increase is relatively small compared with that of the intervention group.

Table 3. Results of the Mann-Whitney Test for Knowledge Differences Between Groups

	Group	Mean	SD	Z	<i>p-value</i>
Pretest	Intervention	19.71	2.737	-0.51	0.959
	Control	20.02	1.189		
Posttest	Intervention	22.22	2.258	-5.907	0.001
	Control	20.49	2.248		

At pre-test, there was no significant difference in knowledge level between the intervention and control groups ($Z = -0.51$, $p = 0.959 > 0.05$), indicating homogeneity of baseline knowledge. The intervention group experienced a substantial increase in mean score, from 19.71 in the pre-test to 22.22 in the post-test (an increase of 2.51 points). Additionally, the change in standard deviation in the intervention group from 2.737 to 2.258 indicates that, after the intervention, adolescents' knowledge became more homogeneous, with reduced variability. In contrast, the control group experienced a minimal increase in the mean score from 20.02 to 20.49 (only 0.47 points). The change in the control group's standard deviation from 1.189 to 2.248 indicates that, without the intervention, knowledge variability increased and became more heterogeneous. At post-test, there was a highly significant difference between the intervention and control groups ($Z = -5.907$, $p = 0.001 < 0.05$), indicating that the interactive crossword game intervention effectively improved adolescents' knowledge of sexually transmitted infections.

**Figure 1.** Students filling in the crossword puzzle

Item-level analysis revealed notable differences between groups. In the intervention group pre-test, Question 20 ("Seeking correct information about STIs is a way to increase adolescent knowledge") answered correctly by 98.0% of respondents, while Question 6 ("Hepatitis A virus is one cause of STI") and Question 14 ("Adolescents who pray regularly and exercise can avoid STI") showed the poorest performance at 27.5% and 49.0% correct, respectively. After the intervention, seven questions achieved 100% correct responses in the intervention group (Questions 1, 2, 4, 7, 9, 21, and 25). Most notably, Question 6 improved from 27.5% to 90.2% correct, and Question 14 improved from 49.0% to 92.2% correct. In contrast, the control group showed minimal improvement, with the same questions remaining problematic areas (Question 6: 23.5% pre-test, 25.5% post-test; Question 14: 49.0% pre-test, 51.0% post-test).

DISCUSSION

The findings of this study demonstrate the significant effectiveness of an interactive crossword puzzle game intervention in improving adolescents' knowledge about sexually transmitted infection prevention. The significant increase in knowledge in the intervention group (from 19.71 to 22.22)

compared to the control group (from 20.02 to 20.49) supports the hypothesis that interactive learning methods are more effective in transferring reproductive health knowledge to adolescents.

These findings align with a systematic review by [Gentry et al., \(2019\)](#) in the Journal of Medical Internet Research, which analyzed 38 studies on serious games and gamification in health professions education. They found that serious games/gamification appeared to be as effective as controls, and in many studies, more effective in improving knowledge, skills, and satisfaction. Although the review noted that the quality of the evidence still needs improvement, the consistency of the findings suggests that interactive methods are superior to conventional learning.

Recent systematic research by [Goldfarb & Constantine \(2020\)](#) in the Journal of Adolescent Health reviewed three decades of comprehensive sex education programs and found that interactive educational interventions significantly improved sexual health knowledge and outcomes. The review emphasized that comprehensive sex education was most effective when programs incorporated engaging, student-centered methodologies rather than didactic instruction, supporting the findings of our crossword puzzle intervention.

The success of this intervention can be explained within Piaget's constructivist framework, which holds that adolescents in the formal operational stage possess optimal abstract and logical thinking skills to absorb complex information about reproductive health ([Inhelder & Piaget, 1958](#)). Crossword puzzles facilitate active knowledge construction through deep cognitive engagement, in contrast to conventional passive learning methods, which tend to lead to low information retention.

Significant increases in understanding of key concepts, such as hepatitis A transmission routes (from 27.5% to 90.2%) and the role of protective factors (from 49% to 92.2%), indicate that this intervention not only increases knowledge but also corrects potentially harmful misconceptions. This aligns with cognitive load theory, which emphasizes the importance of instructional design that optimizes students' working memory capacity ([Abdullah, 2019](#)). This is further supported by [Sweller et al. \(2019\)](#), who explained that effective instructional design reduces extraneous cognitive load by presenting information in manageable chunks and promoting active retrieval practice — mechanisms that enhance long-term retention—precisely what the crossword puzzle format achieves.

This active knowledge-construction process is supported by modern learning theories that emphasize the importance of student engagement. Interactive learning environments, such as crossword puzzles, facilitate in-depth information processing, which fundamentally differs from the shallow processing that occurs in conventional lecture methods.

These findings reinforce the arguments of [Lakoro et al. \(2020\)](#) on the effectiveness of game-based learning, but this study makes a novel contribution by showing that the method not only increased average knowledge but also reduced knowledge disparities between individuals (the standard deviation decreased from 2.737 to 2.258). This phenomenon suggests that interactive crossword puzzles possess adaptive capabilities, enabling adolescents with varying levels of prior knowledge to achieve a more homogeneous understanding ([Lakoro et al., 2020](#)).

This reduction in knowledge disparities is an important finding because it demonstrates that interactive crossword puzzles are not only effective for specific groups but can accommodate learners with varying levels of prior ability. This suggests the existence of adaptive scaffolding mechanisms within the game that enable personalized learning experiences.

The motivational aspect of this intervention can be explained through self-determination theory, where gamification elements in crossword puzzles fulfill adolescents' basic psychological needs for autonomy, competence, and relatedness. This study uncovers the psychological mechanisms underlying the effectiveness of this method through a qualitative analysis of changes in students' perceptions of protective factors ([Angelique et al., 2023](#)).

[Ryan & Deci \(2020\)](#), in their self-determination theory, assert that all humans are born with a tendency to thrive, overcome challenges, and voluntarily integrate new experiences. When basic psychological needs (autonomy, competence, and relatedness) are met, individuals exhibit optimal levels of intrinsic motivation and well-being ([Ryan & Deci, 2020](#)).

The theoretical implication of this study is the development of a reproductive health learning model that integrates edutainment principles with theories of adolescent cognitive development. This model challenges the didactic paradigm of conventional health education and proposes a more participatory and constructive approach.

From a practical application perspective, these findings have significant implications for the development of reproductive health education curricula in secondary schools. The interactive crossword puzzle method can be adopted as a standard pedagogical approach for sensitive topics such as STIs, where conventional approaches often encounter resistance or discomfort among students.

The practical implications of this study extend beyond the immediate classroom setting. First, the crossword puzzle method can be easily adapted and scaled for different educational contexts with minimal resources, making it particularly valuable for resource-limited settings. Second, the collaborative nature of the activity promotes peer learning and reduces the stigma often associated with discussing sexual health topics, creating a more comfortable learning environment. Third, the method can be integrated into existing school health programs without requiring extensive teacher training or technological infrastructure. Educational institutions should consider developing standardized crossword puzzle modules for various reproductive health topics, creating a comprehensive library of interactive learning materials that teachers can readily access and implement.

This study has several limitations that should be considered when interpreting the results. First, the quasi-experimental nonequivalent control group design, while addressing practical constraints in school settings, lacks the randomized group assignment that would further strengthen causal inference. Second, the immediate post-test measurement does not capture long-term knowledge retention or changes in attitudes or behaviors following the intervention. Third, the study was conducted in only two schools in Jambi City, which may limit the generalizability of findings to other geographic regions or socioeconomic contexts. Fourth, additional variables such as perception, attitude, and behavioral intention are not measured, which could provide a more comprehensive understanding of the intervention's impact on reproductive health outcomes.

CONCLUSIONS

The effectiveness of the interactive crossword game education intervention is evident from the achievement of 100% of respondents in the good knowledge category, the dramatic increase in questions that were previously difficult to answer, such as question number 6, which increased from 27.5% to 90.2%, and the achievement of seven questions with 100% correctness. This study demonstrates that interactive crossword game-based education is a highly effective, innovative, and applicable method for improving adolescents' knowledge of sexually transmitted infections, with a far superior level of effectiveness compared to conventional education methods.

This study is expected to serve as a scientific reference and inform the development of preventive programs related to the spread of STIs. Future researchers are expected to use the crossword puzzle game method in providing health education and add other variables, such as perceptions, attitudes, and behaviors of adolescents about STIs, for further research. In addition to adding variables, it is hoped that researchers can also include other topics related to STIs.

ACKNOWLEDGEMENT

The authors would like to thank the entire academic community of the Nursing Science Study Program, Faculty of Medicine and Health Sciences, Jambi University, and all institutions involved in this research for their support of this research.

AUTHOR CONTRIBUTION

BS: Conceptualization, Investigation, Writing Original Draft, Formal Analysis, Visualization. MM: Methodology, Data Curation, Writing – Review & Editing. Author M: Supervision, Writing – Review & Editing. All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

ETHICAL CONSIDERATIONS

Health Ethics Committee of the Faculty of Medicine and Health Sciences, Jambi University (No. 830/UN21.8/PT.01.04/2025) approved the research protocol. The objectives and procedures of this study were explained to the respondents, and the respondents were able to withdraw from the research process. All respondents voluntarily participated in this research and signed the informed consent.

FUNDING

This study received no external funding.

CONFLICT OF INTEREST

The authors hereby declare that there's no conflict of interest in this study, either to any institutions or individuals

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are not publicly available due to privacy or ethical restrictions. However, they are available from the corresponding author on reasonable request and with permission from Jambi University.

PROTOCOL REGISTRATION

This study was not registered.

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