Full research paper

BOOSTING CREATIVE THINKING AND ENTREPRENEURIAL ATTITUDE IN MANADO HIGH SCHOOL STUDENTS: APPLYING SCRUM WITH ETNOCHEMISTRY CONTEXT IN GREEN CHEMISTRY

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ABSTRACT

Scrum is a framework that supports the development of various student skills, yet its application in chemistry learning within the Manado local cultural context remains rare. This study aimed to examine the effect of the scrum method, combined with ethnochemistry, on students' creative thinking skills and entrepreneurial attitudes in green chemistry. Using a quasi-experimental pretest-posttest control-group design, the study involved 110 senior high school students in Manado, divided into an experimental group (55 students) using Scrum with ethnochemistry and a control group (55 students) using conventional learning. Data were analyzed using MANOVA and paired sample *t*-tests. Results showed that the experimental group experienced significant improvements in creative thinking skills and entrepreneurial attitudes compared to the control group. However, the method's complexity posed challenges that affected its overall implementation. Despite these challenges, the Scrum method within the ethnochemistry context proved to have a positive influence on students' skills. Therefore, this method is recommended for broader application in schools to enhance students' creative and entrepreneurial competencies.

KEYWORDS

Creative thinking skills, entrepreneurial behavior, ethnochemistry, green chemistry, Scrum method

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Highlights

- *Scrum with an ethnochemistry context significantly improved students' creative thinking skills and entrepreneurial attitudes compared to the scientific approach.*
- *The experimental group achieved higher N-gain scores in creative thinking (43.49%) and entrepreneurial attitude (26.2%) than the control group.*
- *Scrum fostered collaboration, responsibility, and real-world problem solving through projects grounded in Manado's local culture.*
- *Despite implementation challenges due to method complexity, Scrum proved effective in enhancing key student competencies.*

INTRODUCTION

Education in the 21st century requires students to develop critical thinking, collaboration, communication, and creativity skills, enabling them to adapt and compete in the era of the Fourth Industrial Revolution (Chusni et al., 2020). A 21st-century student-centered learning environment with a personalized approach to learning and active engagement (Mohd & Shahbodin, 2015). This learning environment requires teachers to act as mentors who support each student's learning experience (Harriet Wambui Njui, 2018). However, the study by Muderawan et al. (2019) found that inappropriate learning methods are still being taught. This causes some students to feel bored (Palupi et al., 2018) and difficulties in learning subjects such as chemistry, which are considered abstract and confusing (Prayunisa & Mahariyanti, 2022). Therefore, chemical materials that are relevant to the surrounding environment are needed, such as green chemistry, which reduces the impact of harmful

substances on humans and the environment (Mammino, 2019). An aspect that can enrich the perspective on green chemistry is to relate it to ethnochemistry, the system of people's knowledge of their surrounding environment and the reciprocal relationships that occur within a particular culture (Zidny et al., 2020). The use of ethnochemistrys, such as the use of "saguer" drinks in Manado, which can be processed into alcohol. Ethnochemistry in the classroom can help students understand the concept of chemistry in a cultural context (Fasasi, 2017). Through the study of ethnochemistry, students can continue to inherit cultural heritage, thereby maintaining the values and characteristics of a region. However, teaching that integrates local cultural values in Manado is still limited. Therefore, ethnochemistry research is needed using innovative methods to stimulate students' understanding of chemistry related to culture in Manado.

An interesting introduction to the Scrum method is that it helps the team work flexibly and collaboratively (Schwaber & Sutherland, 2020). The introduction of the scrum method into the learning process has yielded positive results, increasing student initiative and independence (Cook, 2017). Previous studies have demonstrated the potential of Scrum in educational settings, yet its application in chemistry learning, particularly within the ethnochemistry context, remains underexplored. This study addresses the gap identified by Fernandes et al. (2021), who explained that the use of the Scrum method in education remains very limited. That research on it is still exploratory. Therefore, the scrum method is expected not only to be an effective tool for dealing with the complexity of learning but also to develop students' creative thinking skills. Creative thinking among students is necessary to solve daily problems (Retnawati et al., 2018). However, students' creative thinking skills in Indonesia remain in short supply. Research reveals that students generally exhibit significant weaknesses across all aspects of creative thinking (Perdana et al., 2020). This is influenced by various factors, including environment and culture (Nakano and Weschsler, 2018). An entrepreneurial attitude is crucial in learning, enabling students to cultivate motivation and entrepreneurial spirit, thereby fostering independence and job creation (Kamaluddin, 2018). This is based on the low number of entrepreneurs in Indonesia (Indonesia, 2020), which leads to high unemployment and poverty rates (Statistik, 2023). This study examines the impact of the Scrum method on students' creative thinking skills and entrepreneurial attitudes in ethno-chemistry.

Ethno-chemistry in learning contexts

The term ethnoscience is referred to as "original science" or traditional "ecological knowledge", which includes knowledge possessed by indigenous peoples (Zidny et al., 2020). Ethnoscience is the study of community science related to cultural activities in daily life, which is inherited from generation to generation as local wisdom and includes elements of scientific knowledge (Sumarni et al., 2016). In this concept, knowledge is closely related and inseparable from local culture and traditions (Garcia et al., 2020).

The local tradition of the people in the city of Manado, North Sulawesi province, namely "captikus," which is the result of fermentation from the sap of palm trees (*Arenga pinnata Merr*), is generally used by the people of North Sulawesi for alcoholic beverages with an ethanol content of around 30-55%. Captikus drink from the results of redistillation can be used to make natural hand sanitizers from palm sap, which have been shown to reduce the number of bacterial colonies after use (Sari and Ariani, 2023). Additional ingredients can be mixed into hand sanitizer. Clove oil is one of the essential oils that can be added and functions as an antibacterial.

Figure 1: Alcoholic Beverage "Captikus"

Based on this perspective, ethnochemistry encompasses the chemistry of certain indigenous peoples or cultures that have distinct approaches to studying nature. The function of ethnoscience is to facilitate students' exploration of societal facts and phenomena, integrating them with scientific knowledge (Silvia Melyasari et al., 2018). Students have been connected to the culture of life and nature since birth, even before formal education. Ethnoscience that is rooted in students' lives is a form of contextual experience (Parmin & Fibriana, 2019).

Characteristics of learning that integrates ethnoscience according to (Sumarni, 2018), namely (I) incorporating elements of local culture into the learning process such as teaching materials, methods, and various learning media related to local culture into the material to be taught; (II) Students can collect and integrate newly acquired knowledge with known knowledge; (III) Meaningful knowledge occurs when students interact with old information and new information by expanding their knowledge. This process helps learners to broaden their understanding in a significant way.

Scrum methodology

Scrum is a traditional agile method that utilizes sprints and different types of meetings to solve problems during the software development process (Fawareh, Al-Qbelat, and Al-Refai, 2022). Scrum is a working method that helps people, teams, and organizations to generate value through adaptive solutions to complex problems (Schwaber & Sutherland, 2020). Scrum uses an iterative and incremental approach to optimize forecasts and control risks. This methodology involves teams that self-organize, divide roles, measure performance, and execute work cycles (de Melo Jr, 2019). Scrum consists of a group of people who collectively have the skills and expertise to do the job and share or acquire them as needed. The components of Scrum are roles, ceremonies, and artifacts (Schwaber & Sutherland, 2020):

1. Scrum teams use ceremonies to guide their routine activities.
2. Scrum teams use artifacts to visualize and manage the team's progress on the project, ensure transparency, and keep the team focused on the goal. Some of the artifacts used are (Schwaber & Sutherland, 2020):
   a) A product backlog consists of several items needed to achieve project objectives.
   b) The scrum board serves as a transparent tool that provides a glimpse of what has been completed and what still needs to be done.

Step	Ceremony	Roles	Artefacts	Description
1	Introduction	Product owner		Teachers-as-product-owners face various cultural challenges in Manado. Students answer questions given by the teacher
2	Team forming	Scrum master		Students are divided into 4-5 heterogeneous groups. Each group has its own scrum master, and each member of the scrum team has their own tasks.
			Product backlog	The product owner provides a product backlog and explains the learning objectives/outlines.
3	Sprint planning			Students make plans based on learning objectives and the items loaded.
4			Scrum board	Students use it as a transparent tool to provide a glimpse of what has been completed and what still needs to be done.
5	Sprint			After sprint planning, the scrum team carried out their activities over 4 weeks, with about eight meetings lasting 60-90 minutes each.
6	Stand-up			All team members gather around the Scrum board to discuss several things, namely: (1) what they have worked on in the previous lesson, (2) the contribution they will make in the next lesson, and (3) the problems they face.
7	Daily sprint			Students check progress and adapt backlog sprints as necessary, adjusting upcoming work plans.
8	Sprint visit			Students conduct a comparative study of other Scrum teams to better understand.
9	Sprint review		Formative assessment	Students review based on responses from other scrums. The development of students' creative thinking and entrepreneurial attitudes was reviewed using formative assessments.
10	Sprint retrospective			Students conclude and reflect on what they have done.
11	Final product		Summative assessment	Students give the final product they have created. In addition, summative assessments are carried out.

Table 1: A brief overview of the application of the Scrum method with the ethnochemistry context in learning

The most relevant roles in the Scrum method are the Scrum team, the product owner, and the Scrum master. A scrum team typically consists of 5-9 people and does not include the product owner and the scrum master. Each member of the Scrum team has their own role in producing every product improvement (Rising & Janoff, 2000). Three main principles underlie the Scrum methodology, namely transparency, inspection, and adaptation. Its characteristics are as follows (Schwaber & Sutherland, 2020):

a) Transparency requires active involvement in all phases of the project, ensuring visibility to both the party performing the work and the party receiving it.
b) Inspections, scrum artifacts, and any agreed progress should be checked regularly and diligently to detect any unwanted discrepancies or problems and to provide feedback on the product's quality.
c) Adaptation is carried out if there are aspects of the process that deviate beyond acceptable limits or if the resulting product is unacceptable, the method applied, or the materials produced must be adjusted.

The scrum framework encompasses a range of activities, each of which offers an opportunity to assess and refine scrum artifacts. In Scrum, these activities are used to create regularity and minimize various unspecified findings. Various Scrum activities carried out include sprints, sprint planning, daily scrum, sprint review, and sprint retrospective (Schwaber & Sutherland, 2020). Another scrum activity is sprint visits or sprint events, which are considered the core of the scrum method. The goal is to visualize the progress of each sprint in daily meetings, which significantly affects the quality of communication within the research team and the overall success of the project (Ministr, J., Pitner, T., and Danel, R., 2019).

A typical Scrum project in an educational context begins with the teacher taking on the role of the product owner, conveying complex real-world questions to his students through a clear ceremony. Teachers explain learning objectives, relate real-world questions to students' personal lives, and provide artifacts such as scrum boards and product backlogs that list the exercises and tasks needed to answer those questions (Vogelzang et al., 2020b). Table 1 shows the application of the Scrum method with the ethnochemistry context in the classroom and the learning steps carried out (adapted and synthesized from the research (Vogelzang et al., 2021).

Creative thinking skill

Creative thinking is a cognitive process that each individual uses to analyze, plan, conduct investigations, draw conclusions, and identify assumptions, ultimately leading to the right solution (Ceylan, 2020). Creative thinking skills can be measured through several different indicators, namely the *originality* refers to the extent to which a feature is displayed when a person is given a task to complete; Indicators *flexibility* is an approach seen when a person combines several ideas from different situations to achieve the expected result; Indicators *technique* is a measurement of the quality of the day of the work produced; Indicators *resolution* is an indicator that measures the achievement of the goals of a specific project (Forte-Celaya et al., 2021).

The characteristics of creative thinking skills can be observed from: *fluency* refers to the many ideas generated in responding appropriately related to problem solving; *flexibility* is an approach taken when giving an appropriate response in solving a problem; elaboration is a problem-solving to expand the idea of the stimulus given, detailed steps are taken; originality namely the *originality* of the ideas generated in responding to ideas appropriately and being able to produce new products (Kusumah, 2022). Prahani et al. (2021) explain that creative thinking can be trained through indicators of unusual use, problem discovery, product improvement, scientific imagination, creatively designing experiments, creative problem-solving, and creative product design.

Entrepreneurial attitude

The characteristics of an entrepreneur include self-control, drive to achieve success, strong mental well-being, pragmatism, romantic sentiments, and the spirit to face challenges (Matherne et al., 2020). Characteristics of an entrepreneur (Indarto & Santoso, 2020) that a person must have, namely: (1) creative and innovative; (2) have the ability to analyze the situation**; (3) dare to take risks in taking advantage of opportunities; (4) have good intuition so that they can manage their business more effectively; (5) proactive and daring to compete; (6) have goals and targets to be achieved.**

Other characteristics that entrepreneurs tend to show (Scarborough & Cornwall, 2016) are as follows: (1) a high level of commitment; (2) tolerance for ambiguity; (3) creative; (4) flexible; (5) lots of ideas; (6) willingness to work hard; (7) tenacity. The benefits of business ownership for an entrepreneur include the opportunity to create their own destiny, make a difference, reach their full potential, the opportunity to achieve impressive profits, the opportunity to contribute to society and be recognized for the efforts made, and the opportunity to do what they love and have fun with the results achieved (Scarborough & Cornwall, 2016). The spirit of entrepreneurship is significant because it can enhance the potential of human resources, strengthen students' skills through skill development, and encourage independence and job creation in society (Kamaluddin, 2018).

The main goal of this study was to evaluate whether the Scrum method in ethnochemistry learning leads to greater improvements in creative thinking and entrepreneurial attitude than the scientific approach. A secondary goal was to estimate effect sizes and document implementation challenges, providing evidence for future applications.

This study answers the following research questions:

1. Are there differences in creative thinking skills and entrepreneurial attitudes, respectively, in the application of the Scrum method within the ethnochemistry context, compared to learning with a scientific approach on green chemistry material?
2. Are there significant differences in the conditions before and after the application of the ethnochemistry scrum method to green chemistry in terms of creative thinking skills and entrepreneurial attitudes?
3. What is the effective contribution of the application of the scrum method to the creative thinking skills and entrepreneurial attitudes of students simultaneously and individually?

METHODOLOGY

Research design

This study uses a quasi-experimental design with a pretest-posttest control group to examine improvements in creative thinking skills and entrepreneurial attitudes. The study used

two groups: the experimental and the control. The experimental group uses the Scrum method in the ethnochemistry context, while the control group uses a commonly used school-based learning approach, namely, a scientific approach. Scrum was chosen because it provides structured, iterative cycles, visible artifacts (scrum board, product backlog), and role differentiation, which encourage systematic peer feedback and self-regulation. Unlike the conventional scientific approach, which follows linear hypothesis–experiment–report stages, Scrum embeds continuous inspection and adaptation, potentially fostering higher creative ideation and entrepreneurial behaviors (Vogelzang et al., 2021)

Participants

The school sampling technique in this study uses convenience sampling to determine schools. Convenience sampling is a sampling technique based on ease of access and willingness to participate in the study (Creswell, 2014). The sampling process is an essential step in this study to obtain representative data without examining the entire population. Sampling is necessary due to time, manpower, and cost constraints, as well as to ensure the study's results remain valid and generalisable. The research was conducted at a public high school in Manado, involving 110 students from 4 classes. The age range of students in this study was 15-17 years old. Socio-economic background and prior achievement were not controlled. The experimental group (55 students, two classes) comprised 28 females and 27 males. The control group consisted of 55 students from two classes: 31 females and 24 males. The researchers obtained permission from the principal and the school's chemistry teachers.

Research instruments

The Scrum method, with an ethnochemistry context, is applied in a student worksheet that discusses green chemistry in the culture of Manado City. There are three main topics of this learning, namely (1) the importance of green chemistry, the principles of green chemistry, and ethnochemistry processes in daily life; (2) the application of green chemistry principles in the use of alcoholic beverages "saguer" for the manufacture of hand sanitizers; (3) the application of green chemistry principles to the process of making soap from natural ingredients. In this worksheet, the 12 principles of green chemistry are explained, especially in calculating the atomic efficiency of the fermentation reaction of glucose in the beverage "saguer" into ethanol and carbon dioxide, and the atomic efficiency of the reaction of triglycerides with sodium hydroxide to glycerol with soap.

The instrument in this study used an open-ended description test sheet with six questions to measure students' creative thinking skills regarding green chemistry materials, and a questionnaire sheet with 19 items to determine entrepreneurial attitudes. The two instruments were given to students as pre- and post-tests of the learning process using the Scrum method and a scientific approach. Aspects of creative thinking skills and the test instruments used in this study were synthesized from the literature (Ceylan, 2020; Forte-Celaya et al., 2021; Kusumah, 2022; Prahani et al., 2021). Indicators and grids for entrepreneurial attitude instruments were synthesized from the literature (Indarto & Santoso, 2020; Kamaluddin, 2018; Matherne et al., 2020; Scarborough & Cornwall, 2016).

Research procedure

The research was conducted over 6 weeks (the first week for the pre-test and the last for the post-test), and the procedure began with distributing test sheets and questionnaires to students before the lesson. Initially, teachers acting as product owners encountered various cultural challenges in Manado. After that, the teacher explains the various components of the scrum method, and then the students are divided into 4-5 heterogeneous groups. Each group has its own scrum master, and each member of the scrum team has their own tasks.

In the next meeting, the researcher, as a teacher, explained the learning objectives (Figure 2) and the various problems that existed around them. The researcher distributed student worksheets containing multiple products, including problems related to the use of drinking alcohol "captikus", the use of used cooking oil, and waste and product creation. At this stage, students conduct sprint planning based on the loaded learning objectives and items. During sprints, students use the scrum board to indicate what they have done and what to do next. Students conduct daily sprints to check their progress. After discussing in the scrum team, a sprint visit was conducted to gain a deeper understanding of the problems raised. As a result of the sprint visit, the student reviews again. After several scrum series, a sprint retrospective is held to reflect on what has been done. If all these scrum assemblies are considered sufficient, then each scrum team provides the final product in the form of analysis results related to the problems that have been discussed at the meeting.

In the third week, they conducted activities to produce hand sanitizers from alcohol in Manado, applying the principles of green chemistry. Week 4 involved making soap in the city of Manado by combining ingredients, including coconut oil, clove oil, and others, using green chemistry principles throughout the process. In the fifth week, students were given a free practicum to choose between making hand sanitizer or soap. This week, they carried out their own activities without the teacher's guidance. This is done to further develop the various skills they possess. They also conduct a series of sprint activities at each meeting, ensuring learning remains focused.

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Initially, in the control group, teachers also gave worksheets on global problems, but not specific to the culture of the city of Manado. Students form groups, but they are not assigned specific roles. In the core learning activities, students discuss and use the approach that they often use, namely, the scientific approach.

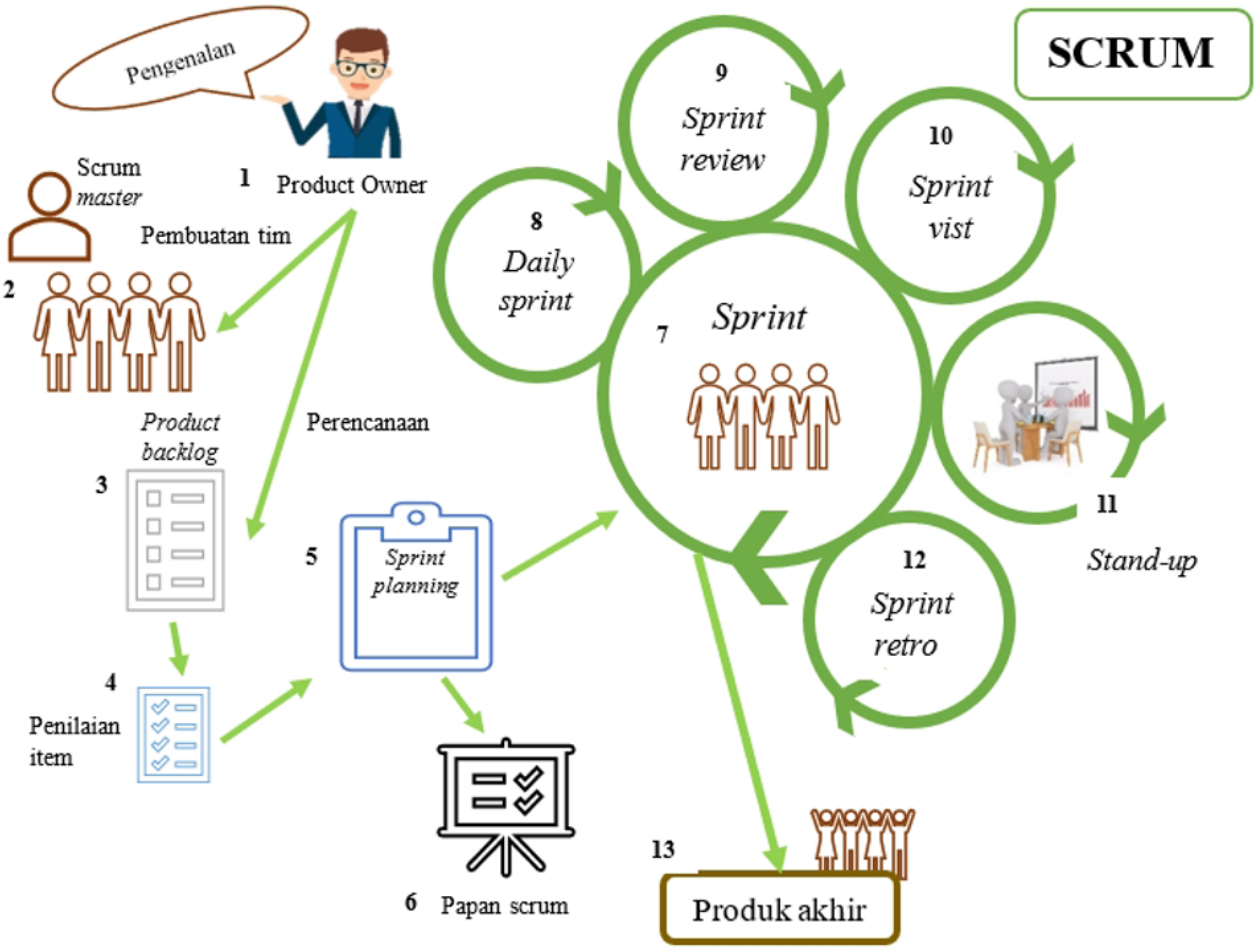

Figure 2: Overview of the Scrum method, taken and synthesized from (Vogelzang et al., 2019)

The control group used the school's standard scientific approach: teacher-led explanation, small group discussion, laboratory tasks, and summative assessments. Unlike Scrum, no role differentiation or systematic formative checks (e.g., stand-ups, backlog reviews) were performed, making this a valid comparator for evaluating Scrum's added value (Vogelzang et al., 2019). Control classes with a scientific approach, without systematic checking, remain valid because they function as a comparison group representing baseline conditions or standard teaching, thereby enabling the attribution of the effects of change to specific elements in the treatment (Scrum with systematic checking). This validity is based on the principle that control classes need not be identical across all aspects of the intervention, as long as they are similar in other characteristics that affect outcomes, such as student demographics or learning context, to isolate the effects of independent variables (Gopalan et al., 2020). This approach is common in educational studies, where control classes often use conventional methods without additional components from the treatment, thereby increasing the internal and external validity of the research. For example, in quasi-experimental designs, control classes help identify causal effects without complete randomization, despite challenges such as selection bias that can be managed through matching or statistical analysis (Brooks et al., 2015; Gopalan et al., 2020).

Reliability and validity of the study

Validity indicates the extent to which an instrument is capable of providing accurate data in accordance with the measurement objectives. Instruments with high validity can accurately measure the desired variables, making validity and reliability tests essential steps in research data collection. In this study, validity tests were conducted theoretically and empirically. Theoretical validity was assessed through expert judgment by three chemistry education professors from Yogyakarta State University for all teaching modules, worksheets, creative thinking skill questions (six essay questions), and questionnaires (20 questions). The results were deemed acceptable after several revisions. Furthermore, the empirical validity of the creative thinking skills questions and the questionnaire was assessed among 243 third-year high school students from three schools in Manado who had studied green chemistry. The empirical validity results show that the six questions are valid, with Pearson correlation coefficients > 0.05 and $p < 0.05$. One item in the questionnaire did not meet the requirements ($p > 0.05$), so 19 items were included. The reliability analysis in this study was conducted by examining Cronbach's alpha coefficients. The reliability of the test instrument was 0.802, which is classified as good reliability, while the reliability of the questionnaire instrument was 0.712, which is classified as moderate reliability.

Data analysis

Data analysis aims to interpret data to inform decision-making or deepen understanding of the observed phenomenon. The data analysis techniques used include inferential statistical methods such as *Normalized-gain* (N-gain), used to determine whether there is an improvement in creative thinking skills and entrepreneurial attitudes. The scores obtained are used to define criteria and establish categories of N-gain effectiveness (Hake, 1998). The N-gain value obtained is then tested using *Multivariate Analysis of Variance* (MANOVA) with prerequisite tests that must be met (Pituch and Stevens, 2016). The results of creative thinking skills and entrepreneurial attitudes showed a significant correlation ($p < 0.05$) with the medium category (Figure 3). All dependent variables showed normal distributions, but the covariance matrix was not homogeneous. After conducting the MANOVA, a paired-samples t-test was used to analyze differences in students' creative thinking skills and entrepreneurial attitudes before and after the implementation of the Scrum method. If there is a significant difference, there is an improvement in their skills and attitudes.

Effect size is used to measure the magnitude of the difference produced by the applied treatment or to assess the extent to which different groups in the population affect dependent variables (Pituch & Stevens, 2016; Stevens, 2009). The multivariate effect size was measured by observing the partial eta square, while the univariate effect size was measured by observing the eta square.

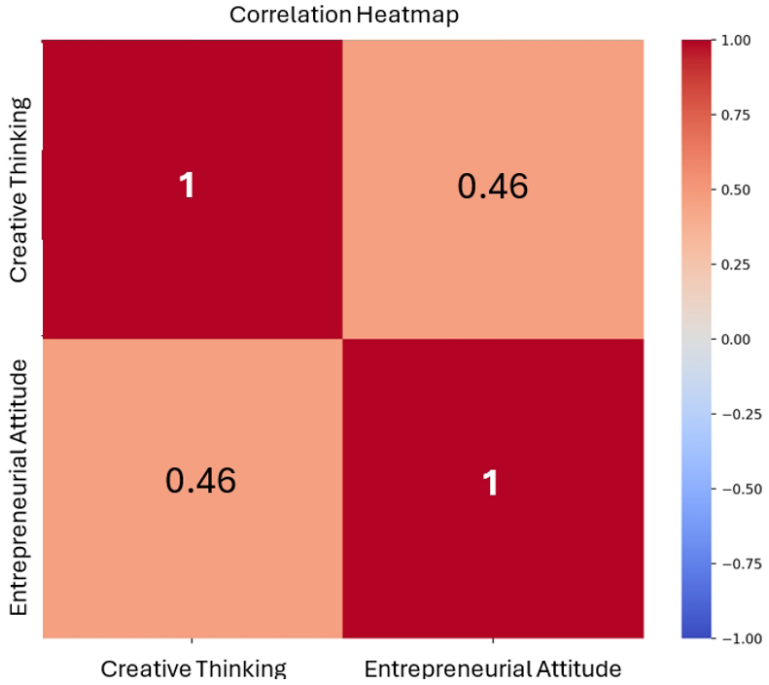

Figure 3: Correlation Between Creative Thinking Skills and Entrepreneurial Attitude

FINDINGS

The results of this study provide an overall overview of the improvement and differences between creative thinking skills and entrepreneurial attitudes of students who use the ethnochemistry context scrum method compared to learning with a scientific approach to green chemistry materials, the results of practical contribution analysis, and differences in creative thinking skills and entrepreneurial attitudes before and after using the ethnochemistry context scrum method.

Students' creative thinking skills and entrepreneurial attitudes

Based on *pre-* and *post-test scores* for six description questions and 19 statement items in the questionnaire, the scores were converted to N-gain values (%) to evaluate the average improvement in students' skills and attitudes. The students' creative thinking skills (Table 2) in the experimental group showed higher post-test scores than in the control group, with an average N-gain of 43.49% and a maximum N-gain of 81.63%. In comparison, the average N-gain in the control group was only 26.34%, and the maximum N-gain was 49.25%. This shows that the creative thinking skills in the experimental group have improved significantly compared to the control class.

The entrepreneurial attitude of students in the experimental group (Table 3) achieved an average N-gain of 26.2% and a maximum of 54.55%. In contrast, students in the control group achieved an average N-gain score of 12.52% and an N-gain value of 27.59. The difference between the two groups was 15.28%, indicating that students in the experimental group had stronger entrepreneurial attitudes than those in the control group.

The results from the experimental group on creative thinking skills and entrepreneurial attitudes suggest that integrating ethnochemistry into the Scrum framework can effectively improve students' abilities. However, the method's complexity may have limited its full potential, suggesting the need for a simpler implementation strategy.

Group	n	Average			Value	
		Pre-test	Post-test	N-gain (%)	N-gain min	N-gain maks
Control	55	34.18	5.02	26.24	6.15	49.25
Experiment	55	34.22	63.47	43.49	11.29	81.63

Table 2: Creative Thinking Skills Results

Group	n	Average			Value	
		Pre-test	Post-test	N-gain (%)	N-gain min	N-gain maks
Control	55	64.94	69.29	12.52	2.38	27.59
Experiment	55	66	75.36	26.2	4.55	54.55

Table 3: Entrepreneurial Attitudes Results

This is based on the N-gain values for creative thinking skills and entrepreneurial attitudes in the experimental group, which are still classified as less effective and ineffective. However, it shows a significant difference compared to the control group. This is because several psychological factors, such as motivation, independence, and students' emotional state, are closely related to the effectiveness of N-gain in learning (Thomas, Müller, and Bieg, 2018). Motivational factors can significantly affect N-gain. These factors play an important role in shaping learning outcomes and N-gain effectiveness in the learning environment (Putra, and Setiani, 2021). The lower N-gain value is also due to the application of the Scrum method in the ethnochemistry context, which has never been taught in school. This is supported by research (Fernandes et al., 2021), which states that studies on the Scrum method in schools are still exploratory and its application remains very limited.

Differences in students' creative thinking skills and entrepreneurial attitudes

The difference in students' creative thinking skills and entrepreneurial attitudes between the experimental and control groups was evident in the comparison of average pre-test and post-test scores (Tables 4 and 5) and the results of the Pillai's Trace test. The average score on each aspect of creative thinking skills in the experimental group showed a larger difference than in the control group. Each indicator of creative thinking skills in the fluency indicator (F = 9.532, $p < 0.05$, η^2 = 0.150), flexibility (F = 15.743, $p < 0.05$, η^2 = 0.226), elaboration (F = 5.961, $p < 0.05$, η^2 = 0.099) showed that there was a significant difference and had a higher value in the experimental group compared to the control group. Meanwhile, there was no significant difference in the originality indicator (F = 1,711, $p > 0.05$, η^2 = 0.099), indicating a small effect. Each aspect of the students › entrepreneurial attitude in the experimental group was optimistic (F = 15,734, $p < 0.05$, η^2 = 0.226), making targets (F = 15,042, $p < 0.05$, η^2 = 0.218), problem solving (F = 32,080, $p < 0.05$, η^2 = 0.373), taking risks (F = 11,986, $p < 0.05$, η^2 = 0.182), discovering new things (F = 22,645, $p < 0.05$, η^2 = 0.295) showed that there was a significant difference compared to the students in the control group. Meanwhile, in the aspect of self-adjustment (F = 3.130, $p > 0.05$, η^2 = 0.055), there was no significant difference.

The Scrum method's contribution to improving students' creative thinking skills and entrepreneurial attitudes

After applying the scrum method to learning in the context of ethnochemistry, the results showed significant differences in creative thinking skills (t = -17,250, $p < 0.05$) and entrepreneurial attitudes (t = -17,790, $p < 0.05$) of students before and after using this method on green chemistry materials. The results showed improvements in their skills and attitudes after implementing the ethnochemistry scrum method. The results of the Pillai's Trace test ($p < 0.05$, partial η^2 = 0.443) indicated a significant difference in the creative thinking skills and entrepreneurial attitudes of students in the experimental group compared to those in the control group. The application of the Scrum method within the ethnochemistry context in the experimental group yielded highly effective contributions to both variants. Meanwhile, when evaluated separately for each bound variable, the effective contribution to students› creative thinking skills (F = 35,551, $p < 0.05$, η^2=0.248) and the entrepreneurial attitude of students (F = 59,365, $p < 0.05$, η^2 = 0.386).

		Experimental group	Control group
		(n = 55)	(n = 55)
Fluency	pre-test	5.33	3.38
	post-test	10.69	7.95
Flexibility	pre-test	8.18	7.49
	post-test	12.56	10.11
Elaboration	pre-test	5.98	7.65
	post-test	13.65	11.20
Originality	pre-test	3.27	4.08
	post-test	7.00	6.33

Table 4: Comparison of Average Pre-test and Post-test Scores of Creative Thinking Skills (minimum score = 1; maximum score = 17)

		Experimental group (n=55)	Control group (n=55)
Optimism	pre-test	4.11	3.45
	post-test	3.95	4.35
Creating a Target	pre-test	3.43	3.37
	post-test	4.02	3.65
Troubleshooting	pre-test	3.19	3.45
	post-test	3.97	3.36
Taking Risks	pre-test	3.47	3.29
	post-test	3.99	3.70
Self-Adjustment	pre-test	3.59	3.38
	post-test	3.83	3.62
Discovering New Things	pre-test	3.49	3.61
	post-test	4.04	3.54

Table 5: Comparison of Average Pre-test and Post-test Scores of Entrepreneurial Attitudes (minimum score = 1; maximum score = 5)

DISCUSSION

There were significant differences in creative thinking skills and entrepreneurial attitudes between the experimental and control groups, attributed to the application of the Scrum method within the ethnochemistry context of the experimental class. Based on research data, students showed increased creative thinking skills and entrepreneurial attitudes after applying the Scrum method in the context of ethnochemistry. This is because the Scrum method can provide feedback on the problems and projects being worked on. Research (Jurado-Navas, and Munoz-Luna, 2017) stated that the application of the scrum method can develop the ability to think independently, improve their critical and creative approaches to knowledge, and enhance their ability to collaborate in a team.

In line with research from (Lourakis, and Petridis, 2023) stated that the Scrum framework is not only effective in developing *soft skill* learners, but also showing a much higher success rate for the learners involved in its collaborative approach, the scrum framework encourages the development of communication, cooperation, creativity, and problem-solving skills that are crucial to their employability. In addition, in line with research (Tomás-Miquel, Fotă, Rodríguez-Máñez, P., and Gajownik, 2022), the application of the scrum method in learning can provide stronger motivation and arouse interest in the business aspect, while also helping overcome various challenges.

Learning with the scrum method enables learners to take on a more active role and assume responsibility for their own learning, with teachers shifting the responsibility to them. Teachers play the role of product owners, which requires them to not only monitor the progress of the learning process, but also play a role in interacting with students to provide relevant experiences for students' future careers (Stytsyuk, Lustina, Sekerin, Martynova, Chernavsky, and Terekhova, 2022). The Scrum method encourages learners to be more active in the projects they work on. This scheme starts with the *product backlog*, which provides an overview of what will be done until the final product is produced. Research (Vogelzang et al., 2020b) explained that various events can be related to the basic concepts and principles of green chemistry that can improve their learning, namely; 1) improve conceptual understanding; 2) guide and encourage to reflect on the principles of green chemistry, work on complex real-world problems related to the concept of green chemistry; 3) strengthen their communication, collaboration, and responsibility skills in their socio-cultural environment.

In this study, students were allowed to use their skills to analyze and answer various green chemistry problems related to the culture of Manado. Students in the experimental class use the *product backlog* as their guide in implementing a project. Before addressing the problem, they first use a plan to ensure their project runs smoothly. At the first meeting, which is to answer environmental problems, after doing *sprint planning*, they visit other groups to exchange ideas and provide feedback so that the goals they make can give better results after the visit, the results they get after the visit are written into student worksheets, the results of *sprint planning* and *sprint visit* reviewed by students so that the problems they discuss can provide accurate answers.

The product of this first learning is a solution to environmental problems related to student culture. The solution was then presented in the classroom. The students' presentation results were rewritten in the student worksheet. During the lesson and at the end, students evaluate the findings they obtain. Through a series of scrums, students can become more organized in solving problems, which, in turn, can make them more creative in providing solutions.

Learning activities using the Scrum method in an ethnochemistry context, such as the daily scrum, are important for developing students' creative thinking skills and entrepreneurial attitudes. By participating in these Scrum activities, students will be trained to take responsibility for the project. For example, they utilize natural ingredients from their culture, such as captikus for product manufacturing (Figure 4), as well as hand sanitizers, coconut oil, and clove oil for bath soap production. By applying the principles of green chemistry they have learned, they achieve sustainable practices. When combined with the challenges of social issues, this approach strengthens students' communication and cooperation skills. It helps them take responsibility in their cultural and social contexts (Vogelzang et al., 2020b). The use of the ethnochemistry context scrum method in the classroom is the first step to developing students' skills.

Figure 4: Results of Manufacturing Ethnochemistry Products

Research (Sumarni & Kadarwati, 2020) stated that to strengthen a more meaningful understanding and improve higher-order thinking skills, consistency in applying critical and creative thinking strategies within a culture-based learning approach is essential. (Sudarmin et al., 2023) In his research, he argues that using a local culture-based learning approach can help students strengthen their positive character during the learning process. The use of the ethnochemistry scrum method provides students with a stimulus to apply their creative thinking skills and entrepreneurial attitude when carrying out a project within a team.

The application of the scrum method provides opportunities for skill development and innovation without hindering the learning process, thereby increasing student motivation, as it is based on project management and creativity (Villarrubia et al., 2024). Research (Vogelzang et al., 2020b) suggests that the scrum method in chemistry learning enhances students' understanding of real-life applications and encourages reflection on the principles of green chemistry. (Vogelzang et al., 2021) He also stated that the Scrum method can enhance learning outcomes, stimulate the learning process, reevaluate learning concepts, and increase student involvement in the project. The observed improvements in creative thinking skills and entrepreneurial attitudes in this study, aligns with the constructivist perspective which states that knowledge is formed through an active process of students in constructing meaning based on involvement and learning experiences (Mugambi, 2018), and also aligns with culturally relevant pedagogy which encourages learning by utilising students' cultural background as the core of their learning process (Mathis, and Southerland, 2022). Our results confirm earlier findings that Scrum enhances student engagement in chemistry contexts (Vogelzang et al., 2020b; 2021). However, this study extends prior work by integrating ethnochemistry as a cultural anchor and by examining entrepreneurial attitudes, an outcome not previously assessed in chemistry education Scrum research (Vogelzang et al., 2020a, 2021). The full Scrum cycle may have imposed excessive complexity for novice learners, increasing extraneous cognitive load. This has likely contributed to lower N-gain effectiveness. Future studies should simplify Scrum by phasing in ceremonies, providing teacher training, and systematically monitoring fidelity. Future research could explore the long-term impact of such interventions and their applicability in different cultural contexts. To address the complexity of the Scrum method with ethnochemistry, future research could explore a simplified version or phased implementation to facilitate broader adoption.

CONCLUSION

Based on the results of the research and discussion that have been explained, it can be concluded as follows: (1) there are differences in creative thinking skills and entrepreneurial attitudes simultaneously and each in learning that uses the scrum method in an ethnochemistry context compared to learning with *a scientific* approach on green chemical matter; (2) there were significant differences in creative thinking skills and entrepreneurial attitudes, respectively, before and after using the ethnochemistry scrum method on green chemistry materials; (3) There was an effective contribution of creative thinking skills of 24.8% and entrepreneurial attitude of 38.6% of students who used the scrum method in the context of ethnochemistry on green chemistry materials and simultaneously by 44.3%. The findings show that applying the scrum method in the context of ethnochemistry increases creative thinking skills and entrepreneurial attitudes. Based on the findings and analysis that have been described, several suggestions can be considered for future research, namely the application of scrum method with ethnochemistry context can be added several chemical projects to improve students' creative thinking and entrepreneurial attitudes, the application of scrum method with ethnochemistry context can be done by adding other variables, further research can be carried out according to the cultural background of other regions.

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