

# Integrating Urinalysis Practicum in Science Education: A Descriptive Study of Urine Characteristics and Its Implications for Students' Conceptual Understanding

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## ABSTRACT

Science education is frequently associated with abstract concepts, thereby necessitating the integration of scientific activities to facilitate students' conceptual understanding. One such activity is the urine content analysis practicum. Urinalysis is conducted by examining the physical and chemical characteristics of urine to support disease diagnosis and to determine normal physiological conditions. Observations typically include changes in color, odor, and specific chemical reactions. This study aims to determine urine pH, detect the presence of ammonia, and identify the existence of glucose, protein, and bile pigments. A descriptive observational method was employed, involving direct examination of urine samples using various chemical reagents. The findings indicate that normal urine exhibits a pH of approximately 5, reflecting a slightly acidic nature. The presence of ammonia is characterized by a more pungent odor, particularly after the urine is heated or left to stand. The bile test results were negative, as indicated by the absence of a green ring formation. Furthermore, the Benedict test for glucose showed no significant color change, and the protein test also yielded negative results, confirming the absence of glucose and protein in normal urine.

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## 1. INTRODUCTION

Science learning fundamentally represents an effort to explore natural and life phenomena in order to identify solutions to various contextual problems (Fathonah, 2021). Therefore, the integration of scientific activities is essential to create meaningful learning experiences while simultaneously fostering students' scientific skills in a comprehensive manner (Firdaus, 2025; Firdaus & Nurohman, 2025). This perspective is further supported by interdisciplinary studies highlighting that scientific understanding is closely linked to broader socio-cultural and environmental contexts.

For instance, the concept of harmony between humans, nature, and the divine in Javanese philosophy reflects a holistic understanding of balance that is also fundamental in scientific systems (Nurziana & Firdaus, 2025). Through laboratory-based activities, such as urinalysis in the topic of the human excretory system, students are not merely engaged in rote memorization of theoretical concepts but are also encouraged to develop scientific attitudes, including accuracy and objectivity, through the analysis of real physical samples. As a form of laboratory work, practicum activities serve to bridge theoretical understanding with practical application, enabling students to deepen their scientific knowledge through measurable empirical experiences, particularly in urine content analysis (Ridwan et al., 2023).

Previous studies have consistently demonstrated that the use of practicum in biology learning, especially in the excretory system topic, plays a significant role as a source of

conceptual understanding. Practicum provides students with direct experiences to observe, test, and verify concepts that are inherently abstract. According to Cimer (2012) as cited in Simorangkir et al. (2020), students' difficulties in understanding biological concepts are largely attributed to the abstract and complex nature of the subject matter, thereby necessitating more concrete instructional approaches such as laboratory activities.

Practicum facilitates the development of science process skills, including observing, measuring, and interpreting data, making learning more meaningful. Furthermore, Simorangkir et al. (2020) found that students' science process skills improved significantly through practicum activities, particularly in experimental and analytical competencies. Thus, practicum in the excretory system, such as urinalysis, is crucial as a conceptual learning resource because it effectively connects theoretical knowledge with real-world phenomena, thereby enhancing students' understanding of complex concepts.

Despite its importance, science learning in schools remains suboptimal. Nofianti et al. (2022) reported that conventional teaching methods, such as lectures, are still predominantly used, resulting in passive learning, low creativity, and decreased student engagement, which ultimately affect students' critical thinking skills. This limitation becomes more critical considering that scientific literacy has direct implications for real-life decision-making, including health behavior and societal well-being, where understanding biological systems and chemical processes significantly influences individual choices (Firdaus et al., 2025).

Teachers often do not adequately assess students' critical thinking abilities, particularly in the excretory system topic, and instructional efforts remain limited to simple activities that do not promote higher-order thinking skills. Another challenge is the limited implementation of practicum due to insufficient laboratory facilities and materials, which restricts students' opportunities to gain direct learning experiences and understand concepts concretely (Supriyanto et al., 2022). Improving the quality of science education therefore requires optimal laboratory management in accordance with governmental standards, as well as the availability of competent laboratory personnel (Evana et al., 2021).

The excretory system is responsible for the removal of metabolic waste products from the human body. These waste substances must be excreted promptly because they are toxic and may harm vital organs if accumulated. One of the primary organs involved in this process is the kidney, which produces urine (Fatirani, 2021). The kidneys, as a pair of organs in the urinary system located in the upper abdominal cavity, function in blood filtration, reabsorption, and secretion through diffusion processes during urine formation. The formation of urine occurs through three main stages: glomerular filtration, tubular reabsorption, and tubular secretion (Budiman et al., 2020).

Urine itself is a complex solution containing both organic and inorganic substances. It consists of salts (NaCl and KCl), urea as a product of protein metabolism, and organic compounds such as creatinine and uric acid, as well as inorganic components including calcium, magnesium, ammonia, phosphate, and sulfate. Additional substances that may be present in urine include protein, acetone, hemoglobin, bile pigments, and glucose. Urinalysis is a diagnostic procedure used to examine urine characteristics by identifying changes in color and odor, which can indicate physiological or pathological conditions (Nugraha et al., 2019).

Urination, or micturition, is the physiological process of emptying the bladder. This mechanism occurs when the urinary bladder is filled with urine, triggering sensory signals transmitted through the spinal cord to the brain, particularly the cerebral cortex, which regulates bladder control. The response is then transmitted back through the spinal cord to the

sacral region, resulting in detrusor muscle contraction and relaxation of the internal sphincter muscles. Several factors influence urine elimination, including diet and fluid intake, the initial urge to urinate, lifestyle, psychological conditions, and activity levels (Uliyah et al., 2022).

The process of urine formation involves the kidneys in maintaining homeostasis, including the regulation of water, ions, proteins, pH, glucose, and other essential substances required for energy. The fluid produced by the kidneys is excreted as urine, which may contain bacteria, viruses, epithelial cells, and extracellular vesicles. The composition of urine is highly dynamic and varies depending on factors such as fluid intake, timing of sample collection, dietary patterns, physical activity, age, gender, medication use, and overall health status (Erdbrügger et al., 2021).

This study is motivated by the observation that science learning, particularly in the excretory system topic, remains insufficient in fostering students' critical thinking skills. Low student engagement and the limited implementation of practicum activities contribute to difficulties in understanding abstract concepts. Therefore, this study aims to introduce a more contextual learning approach through urinalysis practicum, with the expectation of enhancing both conceptual understanding and students' critical thinking abilities.

## **2. METHOD**

This study employed a descriptive observational design aimed at systematically characterizing the properties of urine samples based on direct laboratory examination (Fadha et al., 2021). This approach enables the documentation of observable physical and chemical changes without experimental manipulation.

### **2.1 Participants and Research Setting**

The study was conducted in the Anafis Laboratory of Universitas Trunojoyo Madura. A total of 31 undergraduate students participated in the practicum session, which took place from 14:10 to 15:50 WIB. The participants were involved in conducting and documenting the urine analysis procedures under controlled laboratory conditions.

### **2.2 Materials and Instruments**

The experimental apparatus included test tubes, a test tube rack, a spirit burner for heating, a 100 mL beaker, pipettes for accurate liquid transfer, and tube holders for safe handling during heating. Supporting safety equipment such as gloves, masks, tissues, and matches were also utilized. The materials used consisted of urine samples as the primary specimen, a universal pH indicator to determine acidity, Benedict's reagent for glucose detection, Biuret reagent for protein analysis, and povidone-iodine (Betadine) for bile pigment identification.

### **2.3 Data Collection Technique**

Data were collected through systematic laboratory notes, in which all observable changes such as color variation, odor intensity, and chemical reactions were carefully recorded during each test procedure (Hendrawan et al., 2022).

## Experimental Procedure

The urinalysis consisted of five sequential tests:

1. pH Measurement:  
A 1 mL urine sample was placed in a beaker, and its pH was determined using a universal indicator by matching the resulting color with the standard pH scale.
2. Ammonia Detection Test:  
A 1 mL urine sample was heated using a spirit burner until boiling. The presence of ammonia was identified based on the emergence of a pungent odor.
3. Bile Pigment Test:  
A 2 mL urine sample was placed in a test tube, followed by the careful addition of povidone-iodine until it formed a layer above the urine. The presence of bile pigments was indicated by the formation of a green ring at the interface.
4. Glucose Test (Benedict's Test):  
A 2 mL urine sample was mixed with five drops of Benedict's reagent and heated. A color change indicated the presence of glucose.
5. Protein Test (Biuret Test):  
A 2 mL urine sample was mixed with five drops of Biuret reagent and allowed to stand for five minutes. Any resulting color change indicated the presence of protein.

## 2.4 Data Analysis

The collected data were analyzed using descriptive analysis, focusing on identifying patterns and interpreting observable changes in each test to determine the chemical composition of the urine samples. The study involved the following variables:

- Object of study: urine sample
- Dependent variables: urine characteristics (pH, ammonia, bile pigments, glucose, and protein content)
- Independent variables: chemical reagents used (universal pH indicator, Benedict's reagent, Biuret reagent, and povidone-iodine)

## 3. RESULT AND DISCUSSION

The results of the urinalysis indicate that the examined sample exhibits characteristics consistent with normal urine composition. The pH test revealed a value of 5, which falls within the normal physiological range (pH 4–8), indicating a slightly acidic condition. This finding aligns with previous studies reporting that normal human urine typically ranges between pH 4.5 and 8 (Penggali et al., 2021).

In the ammonia test, no distinct odor was detected prior to heating. However, after thermal exposure, a pungent odor emerged, indicating the presence of ammonia. This phenomenon can be attributed to the decomposition of urea into ammonia, which becomes more volatile when heated (Wahyudi et al., 2023). The presence of ammonia is a common characteristic of urine and reflects normal metabolic waste processes.

The bile pigment test showed negative results, as evidenced by the absence of a green ring at the interface between urine and povidone-iodine. This indicates that the sample did not contain bile pigments such as bilirubin, which are typically absent in normal urine but may appear under pathological conditions (Budiani et al., 2023).

In the glucose test using Benedict’s reagent, the solution changed from yellow to blue after heating, indicating the presence of trace amounts of glucose. Although normal urine generally does not contain detectable glucose, very small concentrations may still be present and are often considered physiologically insignificant (Tandra, 2017). Similarly, the protein test using Biuret reagent showed a bluish-green coloration, which indicates a negative result for protein presence. The absence of protein suggests normal kidney filtration function, as proteinuria is typically associated with renal dysfunction (Purwaningsih et al., 2024).

The results demonstrate consistency across all indicators of urinalysis, confirming that the tested sample falls within normal parameters in the table 1. No significant experimental errors were identified, as the observed color changes and odor responses were consistent with established chemical reactions and theoretical expectations.

**Table 1.** Results of Urinalysis Based on Physical and Chemical Characteristics

Test	Before Treatment	After Treatment	Interpretation
pH	-	5 (acidic)	Normal
Ammonia	Odorless	Pungent	Present
Bile	No green ring	No green ring	Negative
Glucose	Yellow	Blue	Trace amount detected
Protein	Yellow	Bluish-green	Negative

This study underscores the pedagogical significance of urinalysis practicum as an effective instructional strategy in science education, particularly within the context of teaching the human excretory system. The practicum exemplifies the integration of contextual learning and inquiry-based approaches, where students actively construct knowledge through direct engagement with empirical evidence (Rahayu et al., 2023). Such approaches are widely recognized in contemporary science education for bridging the gap between abstract biological concepts and observable real-world phenomena. In addressing global challenges, where scientific understanding is required to support sustainable development, including issues related to resource management, food systems, and environmental resilience (Haikal et al., 2025).

Through hands-on experimentation, students are not merely passive recipients of information but become active investigators who interpret scientific evidence. The observation of urine pH, ammonia odor, and the absence of glucose and protein enables learners to concretize complex physiological processes such as glomerular filtration, tubular reabsorption, and metabolic waste excretion. This experiential engagement supports conceptual change by allowing students to validate theoretical knowledge through observable outcomes, thereby reducing misconceptions that often arise in abstract learning contexts.

Furthermore, the practicum facilitates the development of higher-order thinking skills, particularly analytical and interpretative abilities. Students are required to systematically observe changes, compare results with established scientific standards, and draw evidence-based conclusions. This aligns with the broader goals of science education, which emphasize not only content mastery but also the cultivation of scientific literacy and inquiry competencies (Dewi & Riyanti, 2024). The ability to interpret biochemical indicators in urine, for instance,

reflects an application of knowledge in a meaningful and health-related context, thereby increasing the relevance of learning.

In addition, the integration of urinalysis activities contributes to the development of scientific attitudes, such as accuracy, objectivity, and curiosity. The structured observation process encourages students to record data systematically and interpret results cautiously, which are essential components of authentic scientific practice. This aligns with constructivist learning theory, which posits that knowledge is actively built through interaction with the environment and reflective thinking.

From a broader perspective, the implementation of this practicum also supports context-based and life-relevant learning, as students are introduced to diagnostic procedures commonly used in medical and clinical settings. This not only enhances engagement but also fosters awareness of the practical applications of science in everyday life, particularly in maintaining health and understanding bodily functions. In a wider context, this type of scientific literacy is also essential in supporting sustainability transitions, such as the implementation of circular economy practices and green economic systems, which rely heavily on scientific innovation and environmental awareness (Firdaus & Alifiyah, 2025). Moreover, the effectiveness of such transitions is influenced by the capacity of policymakers to translate scientific knowledge into strategic actions, highlighting the importance of strengthening green competencies at the institutional level (Karuniasa & Firdaus, 2025).

Therefore, urinalysis practicum extends beyond its function as a laboratory activity; it serves as a multidimensional learning tool that integrates conceptual understanding, process skills, and real-world relevance. Its implementation has the potential to improve learning outcomes by promoting active participation, deeper understanding, and the development of essential 21st-century scientific competencies.

#### **4. CONCLUSION**

The urinalysis practicum successfully identified key characteristics of normal urine, including a slightly acidic pH, the presence of ammonia, and the absence of bile pigments and protein, with only trace amounts of glucose detected. These results confirm that the tested sample falls within normal physiological parameters and demonstrate the reliability of simple qualitative laboratory tests in analyzing urine composition. From an educational perspective, the implementation of urinalysis practicum proves to be an effective contextual and inquiry-based learning strategy. The activity facilitates students' understanding of abstract biological processes through direct empirical observation, while also enhancing scientific literacy, critical thinking, and process skills. Therefore, this practicum not only supports conceptual mastery in the excretory system topic but also contributes to the development of essential scientific competencies, making it a valuable approach for meaningful and active science learning.

#### **REFERENCES**

- Budiani, D. M., et al. (2023). *Mengatasi obesitas dengan asupan nutrisi berbahan tepung porang terfortifikasi tepung daun*. Deepublish Digital.
- Budiman, J. W., Muninggar, J., & Surtresno, A. (2020). Investigasi difusi pada sistem urinari untuk gangguan fungsi ginjal model empat kompartemen menggunakan metode Monte Carlo. *Jurnal Fisika dan Aplikasinya*, 16(1), 24–28.
- Cimer, A. (2012). What makes biology learning difficult and effective: Students' views. *Educational Research and Reviews*, 7(3), 61–71.

- Dewi, S., & Riyanti, R. (2024). Pembelajaran biologi konsep sistem ekskresi menggunakan teknologi augmented reality terhadap keterampilan proses sains (KPS) peserta didik di SMAN 2 Maros. *Jurnal Binomial*, 7(2), 69–79. <https://doi.org/10.46918/bn.v7i2.2441>
- Erdbrügger, U., et al. (2021). Urinary extracellular vesicles: A position paper by the Urine Task Force of the International Society for Extracellular Vesicles. *Journal of Extracellular Vesicles*, 10(7), 1–39.
- Evana, Y., Fitria, H., & Fitriani, Y. (2021). The management of science laboratory at senior high school in digital era. *Jurnal IICET*, 6(3), 660–667.
- Fadha, G. S., Supriadi, S., Supriatno, B., & Anggraeni, S. (2021). Analisis lembar kerja peserta didik (LKPD) praktikum uji urin berbasis ANCORB. *Bioscientist: Jurnal Ilmiah Biologi*, 9(2), 286–296.
- Fatirani, H. (2021). *Pembelajaran kooperatif tipe jigsaw pada sistem ekskresi manusia*. Pusat Pengembangan dan Pendidikan Indonesia.
- Fatonah, S. (2021). Eksplorasi kegiatan praktikum IPA PGMI selama pandemi COVID-19. *SAP (Susunan Artikel Pendidikan)*, 6(1), 1–10.
- Firdaus, T. (2025). Research and Trends of Socio-Scientific Issues in Natural Science Education: Bibliometric and Content Analysis Based on Systematic Literature Review. *Journal of Progressive Science Education*, 1(1), 1–18.
- Firdaus, T., & Nurohman, S. (2025, September). The Role of Artificial Intelligence in Science Education: Enhancing Student Engagement and Preparing the Foundations for Future Education through Digital Literacy. In *2025 International Workshop on Artificial Intelligence and Education (WAIE)* (pp. 181–185). IEEE. doi: 10.1109/WAIE67422.2025.11381299.
- Firdaus, T., & Alifiyah, F. L. N. (2025). Circular Economy In The Palm Oil Industry: Global Trends, Potentials, and Opportunities for Green Economy In Indonesia. *International Journal of Oil Palm*, 8(2), 1–16. <https://doi.org/10.35876/ijop.v8i2.125>
- Firdaus, T., Bakari, L. Y., Hidayah, N., Munawaroh, S., & Djano, U. K. (2025). The Influence of Understanding the Human Body System, Chemical Reactions, and Energy on Health Decisions and Eating Patterns in Society. *REFTEKS: Jurnal Referensi Teknologi, Kesehatan, dan Sains*, 1(1), 15–27.
- Haikal, R., Firdaus, T., Herdiansyah, H., & Chairunnisa, R. S. (2025). Urban Planning Policies and Architectural Design for Sustainable Food Security: A Case Study of Smart Cities in Indonesia. *Sustainability*, 17(16), 7546. <https://doi.org/10.3390/su17167546>
- Hendrawan, J., Nurfaika, S., Rahmayanti, N., Ramadhani, Z., Setiyawan, R., & Sulaeman, N. F. (2022). Pengelolaan laboratorium fisika SMA di Kota Samarinda pada era digital. *Jurnal Pembelajaran Fisika*, 11(4), 151–158.
- Karuniasa, M., & Firdaus, T. (2025). Points of Entry for Enhancing Policymakers' Capacity to Develop Green Economy Agenda-Setting. *Sustainability*, 17(23), 10727. <https://doi.org/10.3390/su172310727>
- Nofianti, E., Nurhidayanti, A., Handayani, N. A., Rosana, D., & Wilujeng, I. (2022). Profil berpikir kritis peserta didik SMP pada materi sistem ekskresi manusia. *Jurnal Pendidikan Sains Indonesia*, 10(3), 479–491.
- Nugraha, J., et al. (2019). *Analisis cairan tubuh dan urine*. Airlangga University Press.
- Nurziana, S., & Firdaus, T. (2025). The concept of divinity in Javanese mysticism: Viewing the universe as a manifestation of God. *Samsara: International Journal of Eastern Philosophy*, 1(1), 1–11.

- Penggalih, M. H. S. T., et al. (2021). *Gizi olahraga II: Respons adaptasi biokimia dan fisiologi atlet*. Gadjah Mada University Press.
- Purwaningsih, N. V., Widyastuti, R., & Sari, E. T. M. (2024). *Urinalisis dan cairan tubuh*. Rena Cipta Mandiri.
- Rahayu, S. F., Ulfah, M., Agustini, F., & Kusumawati, Y. (2023). Peningkatan hasil belajar kognitif siswa materi sistem ekskresi dengan metode praktikum. *Bioed: Jurnal Pendidikan Biologi*, 11(2), 122-127.
- Ridwan, I., Anggraeni, S., & Supriyatno, B. (2020). Analisis lembar kerja peserta didik sekolah menengah atas pada praktikum uji urin. *BIODIK: Jurnal Ilmiah Pendidikan Biologi*, 6(3), 319-327.
- Simorangkir, A., Napitupulu, M. A., & Sinaga, T. (2020). Analisis kesulitan belajar siswa pada materi sistem ekskresi manusia. *Jurnal Pelita Pendidikan*, 8(1), 1-11.
- Supriyanto, A., Suciwati, S. W., Marjunus, R., & Manurung, P. (2022). Pelatihan pengelolaan dan pengembangan laboratorium fisika SMA Kabupaten Lampung Tengah. *NEAR: Jurnal Pengabdian kepada Masyarakat*, 1(2), 127-133.
- Tandra, H. (2017). *Segala sesuatu yang harus Anda ketahui tentang diabetes*. PT Gramedia Pustaka Utama.
- Uliyah, M., et al. (2022). *Kuliah keperawatan dasar 1*. UM Surabaya Publishing.
- Wahyudi, D., Erwanto, D., & Rizal, R. F. (2023). Sistem electronic nose untuk deteksi aroma pada fasilitas kamar mandi berbasis IoT. *Zetroem*, 5(1), 43-50.