

Enhancing Biology Learning through Microtechnics: Collaboration for Creativity and Innovation

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Keywords: Microtechnical Competence, Learning, Economy.		Abstract. The Microtechnique Competency Development Program at SMA Negeri 1 Remboken was designed to strengthen teacher and student skills in preparing microscopic slides as instructional media for biology learning. A preliminary assessment in 2024 showed that laboratory facilities were underutilized, with only 28% of scheduled biology practical sessions fully implemented, while most activities remained lecture-based. Furthermore, a competency evaluation involving 30 students and 6 teachers revealed that fewer than 35% demonstrated adequate microtechnique skills, particularly in preparing and observing biological specimens. These findings highlighted the urgency of providing systematic training to optimize laboratory use. The program adopted the Asset-Based Community Development (ABCD) approach, mobilizing local assets such as teacher-student enthusiasm, available laboratory equipment, and institutional knowledge. The implementation process consisted of asset mapping, technical training, collaborative mentoring, and the development of a Problem-Based Learning (PjBL)-based teaching module. Training activities focused on three core microtechnique practices: squash preparations of onion (<i>Allium cepa</i>) and garlic (<i>Allium sativum</i>) root tips for mitosis observation, wholemount preparation of head lice (<i>Pediculus humanus capitis</i>), and chicken blood smear (<i>Gallus sp.</i>) slides. Program evaluation demonstrated measurable improvement, with mean scores increasing from 45 (pre-test) to 72.5 (post-test). A paired-sample t-test confirmed the improvement was statistically significant ($p < 0.05$). In total, 55 slides were produced, of which 37 met the criteria of “educationally viable,” defined by specimen clarity, staining quality, and suitability for classroom use. Beyond technical skill enhancement, the program fostered collaborative culture and strengthened the laboratory’s role as a hub for educational innovation and creative economy development.			
Katakunci: Kompetensi Mikroteknik, Pembelajaran Ekonomi Kreatif.		Abstrak. Program Pengembangan Kompetensi Mikroteknik di SMA Negeri 1 Remboken dirancang untuk meningkatkan keterampilan guru dan siswa dalam menyiapkan preparat mikroskopis sebagai media pembelajaran biologi. Hasil asesmen awal tahun 2024 menunjukkan bahwa fasilitas laboratorium masih kurang dimanfaatkan, dengan hanya 28% jadwal praktikum biologi yang terlaksana secara penuh, sementara sebagian besar kegiatan masih berbasis ceramah. Selain itu, evaluasi kompetensi terhadap 30			

siswa dan 6 guru mengungkapkan bahwa kurang dari 35% memiliki keterampilan mikroteknik memadai, khususnya dalam menyiapkan dan mengamati spesimen biologi. Temuan ini menegaskan pentingnya pelatihan sistematis untuk mengoptimalkan pemanfaatan laboratorium. Program ini menggunakan pendekatan Asset-Based Community Development (ABCD), dengan memobilisasi aset lokal seperti antusiasme guru-siswa, ketersediaan peralatan laboratorium, dan pengetahuan kelembagaan. Proses pelaksanaan meliputi pemetaan aset, pelatihan teknis, pendampingan kolaboratif, serta penyusunan modul pembelajaran berbasis Problem-Based Learning (PjBL). Kegiatan pelatihan difokuskan pada tiga praktik utama mikroteknik: preparat squash ujung akar bawang merah (*Allium cepa*) dan bawang putih (*Allium sativum*) untuk pengamatan mitosis, preparat utuh kutu kepala (*Pediculus humanus capitis*), dan preparat darah ayam (*Gallus sp.*).

Evaluasi program menunjukkan adanya peningkatan kinerja peserta, dengan nilai rata-rata naik dari 45 (pre-test) menjadi 72,5 (post-test). Uji *t* berpasangan membuktikan perbedaan ini signifikan secara statistik ($p < 0,05$). Dari total 55 preparat yang dihasilkan, 37 memenuhi kriteria “layak edukasi” berdasarkan kejernihan spesimen, kualitas pewarnaan, dan kesesuaian untuk penggunaan kelas. Lebih dari peningkatan teknis, program ini menumbuhkan budaya kolaboratif dan memperkuat laboratorium sebagai pusat inovasi pendidikan dan pengembangan ekonomi kreatif.

1 Introduction

One of the key aspects in enhancing the quality of science education is the development of practical skills that are relevant to current technologies (Forde & OBrien, 2022). Microtechnique—which includes fixation, dehydration, staining, and mounting of microscopic specimens—significantly contributes to deepening students' understanding of cellular and tissue structures (Isaac et al., 2023). Beyond its scientific value, microtechnique can also be linked to the creative economy in secondary schools, for example by enabling students to produce high-quality prepared slides that can be packaged as educational products, teaching aids, or even innovative learning media with commercial potential. This connection fosters both scientific competence and entrepreneurial skills among students (Agustina et al., 2024).

Creative economy education has been proven to foster students' innovative character from an early age, with schools playing a strategic role as incubators in producing a creative and adaptive generation responsive to the demands of a changing era (Pambudi, 2021). SMA Negeri 1 Remboken, with the National School Identification Number (NPSN) 40100870, is a public secondary education institution in Minahasa Regency, North Sulawesi. The school has considerable potential for strengthening practice-based science education, supported by existing laboratory facilities. However, the use of these facilities remains limited. The main constraints are the insufficient technical skills of both teachers and students in preparing and using microscope slides, as well as the poor condition and limited relevance of the available slides (Maity et al., 2023).

This reality has led science education—particularly in biology and chemistry—to focus predominantly on theoretical aspects, with minimal emphasis on hands-on activities that should be central to the scientific approach promoted by the Merdeka Curriculum (Tarigan et al., 2025). In fact, the school is surrounded by forests and agricultural land rich in biological resources, such as plants and small animals, which hold great potential for use in microtechnique practices (Iqbal et al., 2023).

Discussions with the school identified two urgent core issues: first, from a production standpoint, there is a low level of competence among teachers and students in producing high-quality microscopic slides, and there is also an absence of contextual laboratory modules aligned with the Merdeka Curriculum (Yunus et al., 2025). Second, from a socio-economic perspective, there have been no efforts to convert laboratory results into educational products with economic value, nor has there been any significant digital entrepreneurship training within the school environment.

This community service program aims not only to improve laboratory skills, but also to focus on converting practical results into marketable educational products. To this end, a contextual laboratory module based on Problem-Based Learning (PjBL) has been developed, along with digital entrepreneurship training sessions utilizing social media and e-commerce as marketing tools (Tan et al., 2025).

Consequently, this program supports the achievement of more practical and applied science learning while fostering a school-based entrepreneurial spirit and reinforcing the function of the school laboratory as an innovation hub (Kahangwa, 2025).

The Microtechnique Competency and Digital Entrepreneurship Development Program at SMA Negeri 1 Remboken introduces innovation in the empowerment approach by utilizing school laboratories not only for conventional science learning but also for training in microtechnique skills and product development. Its novelty lies in the systematic integration of laboratory-based practice, entrepreneurial digitalization, and the use of local biological resources as teaching and business materials. This integration creates opportunities for students to acquire both scientific competencies and entrepreneurial skills, which are rarely combined in similar school programs

First; Integrating Microtechniques and School-Based Digital Entrepreneurship, this initiative stands as one of the pioneering efforts at the senior high school (SMA) level to simultaneously combine technical microtechnique training with the enhancement of digital entrepreneurship capacity. Typically, microtechnique training focuses solely on improving laboratory skills without incorporating strategies for utilizing practicum outputs as economically valuable products. In this program, teachers and students are not only trained to independently produce microscopic preparations but are also equipped with the skills to package, promote, and market these products as educational media through digital platforms such as online marketplaces and social media. This approach creates a bridge between the school laboratory and the entrepreneurial world, positioning science as a vital component of the creative economy ecosystem (Lazzaro, 2021).

Second; Development of Contextual Practicum Modules Based on Problem-Based Learning (PjBL). Complementing the technical training, a contextual practicum module based on Problem-Based Learning has been developed, aligned with the local biodiversity potential surrounding the school, such as agricultural plants and indigenous organisms. This module not only provides technical guidelines for creating preparations but also presents real-world problems that students must collaboratively

and scientifically solve. As a result, the learning of biology and chemistry is no longer confined to classrooms or dependent on factory-made tools, but becomes an exploratory, contextually adaptive process (Doğan et al., 2023). The module is also designed in alignment with the Merdeka Curriculum, making practicum implementation more meaningful and supportive of the Profil Pelajar Pancasila (Pancasila Student Profile).

Third; Optimizing the Laboratory as an Incubator for Educational Products and the Creative Economy. Within this program, the school laboratory is not merely a complementary space for learning, but is optimized as an innovation incubator. Preparations produced through the training process are curated and professionally repackaged to serve as interactive teaching materials and visually engaging learning media with both educational and economic value. By strengthening production management and digital marketing strategies, the laboratory is transformed into a school-based economic empowerment hub, where teachers and students produce and distribute educational products to other schools, educational communities, and the wider public. This initiative enables schools to assume a dual role: as centers of education and as agents of the local creative economy driven by science and technology. This program aligns with the achievement of the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) by promoting practice-based and technology-integrated learning, and SDG 8 (Decent Work and Economic Growth) by reinforcing the role of schools as local creative economy actors (Muharam et al., 2024).

2 Method

The Microtechnical Skills Development Program was implemented at SMA Negeri 1 Remboken, located in Minahasa Regency, North Sulawesi. The program engaged four science teachers specializing in Biology and Chemistry, fifteen student council (OSIS) members, and the school principal, who served as the institutional coordinator. The selection of this school was based on preliminary field observations, which indicated a low level of laboratory utilization. This underutilization was primarily due to the limited technical competencies among both teachers and students in conducting microtechnique-based laboratory

activities, as well as the absence of practical modules aligned with the Kurikulum Merdeka (Independence Curriculum).

The program was conducted using the Asset-Based Community Development (ABCD) approach, which emphasizes local strengths and participatory collaboration. The implementation followed five structured stages as outlined in the Appreciative Inquiry (AI) cycle: Discovery, Dream, Design, Destiny, and Reflection.

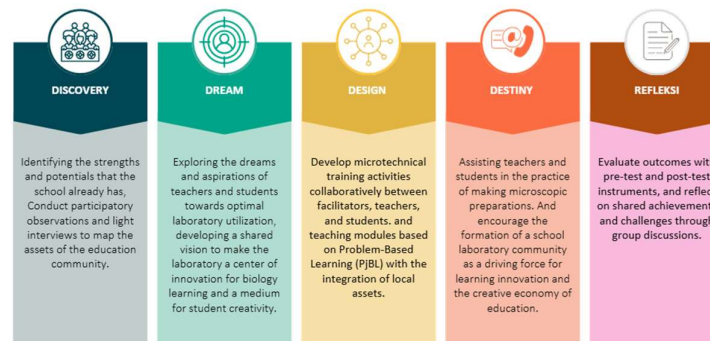


Figure 1. Stages of Implementing Community Service Activities Using The ABCD Method

The figure illustrates a five-stage framework for implementing a capacity-building program for teachers and students using the Appreciative Inquiry approach. This framework is designed to support the development of a school-based science laboratory as a center for both educational innovation and creative economy initiatives. Each phase represents a participatory and systematic process—from needs identification to outcome evaluation.

The first stage, Discovery, involves identifying the existing strengths, resources, and challenges within the school environment. This is achieved through participatory observations and informal interviews with teachers and students. The goal is to map educational assets, particularly in terms of laboratory facilities and potential for science learning enhancement.

The second stage, Dream, focuses on exploring the aspirations of teachers and students regarding optimal laboratory utilization. Through collaborative discussions, participants envision a shared goal of transforming the school laboratory into a hub for innovative biology

education and student creativity. This phase also includes identifying relevant skill sets required for developing educational products with economic value.

In the Design phase, teachers and students are actively involved as co-creators in the development of problem-based learning (PjBL) modules that integrate local resources. This stage includes hands-on microtechnical workshops where participants learn and practice three primary techniques: smear (for observing blood cell morphology), wholemount (for analyzing the morphology and anatomy of small specimens using 10% KOH fixation), and squash (for examining cell division in meristematic tissues). The training also includes instructional module development to ensure sustainable classroom application.

The Destiny stage is oriented toward implementation. Teachers and students apply the microtechnical skills acquired during the workshop and begin producing microscopic preparations. Additionally, the program supports the formation of a laboratory-based learning community within the school, aimed at sustaining educational innovation. As part of the school's creative economy development, students receive training in digital marketing to promote and sell the microscopic products through digital platforms, including e-commerce and social media.

The final stage, Reflection, centers on evaluating the outcomes of the program. This includes administering pre-test and post-test instruments to measure participants' knowledge and skill acquisition. Group discussions and satisfaction surveys are also conducted to assess the effectiveness of the activities and to identify both achievements and areas for improvement. This reflective process serves as a foundation for ensuring the sustainability and scalability of the program.

Overall, the program adopts a participatory approach in which teachers and students serve as active agents throughout all stages. By leveraging local resources and integrating educational innovation with entrepreneurship, the program aims to enhance science learning while promoting the school's role in the broader context of the creative economy.

3 Results

Applying the ABCD model in empowering women housewives with an integrated fish and plant cultivation system (Budikdamber), is very efficient because it combines two production systems in one container, namely catfish farming and hydroponic plants (such as kale). The ABCD steps implemented are

The implementation of the Microtechnical Skills Development Program at SMA Negeri 1 Remboken took place dynamically over the course of June and July, and was structured into three key phases: preparation, implementation, and evaluation.

During the preparation phase, the organizing team coordinated closely with the school administration to ensure effective program delivery. Laboratory infrastructure was prepared, and essential materials such as practical modules, presentation media, and laboratory specimens—including chicken blood, human hair lice, and onion bulbs—were provided to support hands-on microtechnical practice.

The implementation phase began with a pre-test to assess participants' baseline knowledge. The core activities involved a balanced integration of theoretical instruction and practical training. Participants were guided through three core microtechnical procedures: smear (to observe blood cell morphology), wholemount (to examine the morphology and anatomy of small specimens), and squash (to study cell division in meristematic tissues).

In addition to the technical training, the program incorporated Problem-Based Learning (PjBL) module development workshops for teachers, enabling them to independently implement these methods in classroom settings. Furthermore, digital marketing training sessions were delivered to students to enhance their understanding of how to market educational products online, promoting entrepreneurial and creative economy skills.

The evaluation phase revealed a significant improvement in participants' competencies. Post-test results showed a marked increase

in the average score, rising from 45 in the pre-test to 72.5 in the post-test—an improvement of 61.11% (Figure 2). This outcome demonstrates the program's effectiveness in enhancing both pedagogical and practical capabilities in science education.

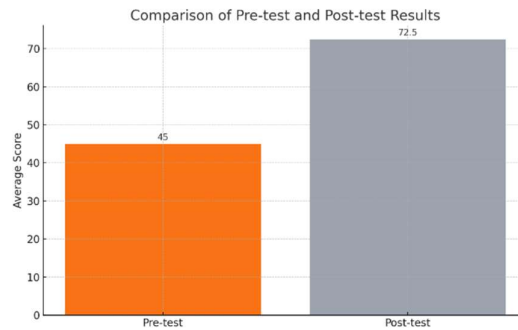


Figure 2. Bar Chart Showing The Pre-Test and Post-Test Results of Microtechnique Training Participants.

In addition to the knowledge and skills gained, the program also yielded tangible outputs from the practical sessions. Participants successfully produced a total of 55 microscopic preparations, consisting of 12 chicken blood smear slides, 15 wholemount slides of head lice, and 28 squash preparations from onion root tips. Among these, 37 preparations were deemed suitable for distribution as educational products, while the remaining 18 preparations were considered substandard due to quality issues that did not meet the minimum criteria for educational use.

Participant satisfaction was assessed across three major domains: training content, facilities, and practical usefulness. Using a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree), the post-training survey revealed a high level of satisfaction among participants. The training content was rated as highly relevant, particularly in terms of expanding participants' scientific insight and technical competencies. The highest mean score was recorded on the indicator of enhanced knowledge and skills (4.79), followed by the relevance of the digital marketing module (4.53), demonstrating the participants' appreciation for the integration of entrepreneurial elements into the science-based training (Figure 3).

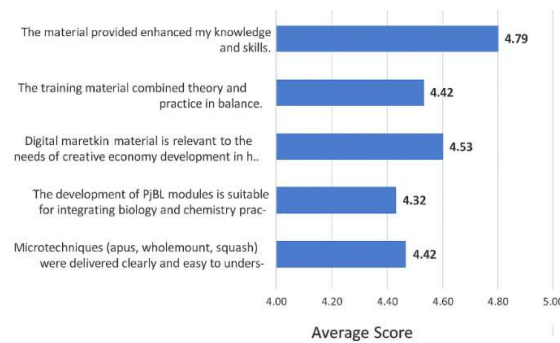


Figure 3. Results of Participant Satisfaction Survey in The Training Material Category.

The training facilities, particularly the availability of laboratory equipment and materials, were rated as highly satisfactory by participants, receiving a mean score of 4.84. Meanwhile, supporting media such as modules and projectors also received a strong rating of 4.53, indicating the adequacy of instructional aids provided throughout the program (Figure 4). In terms of practical applicability, participants reported increased confidence in applying microtechnical procedures and initiating creative economic activities within the school setting, as reflected in a satisfaction score of 4.58 (Figure 5).

The mentoring dynamics throughout the program revealed a high level of engagement among both teachers and students. This was evidenced by their ability to produce high-quality microscopic slides, collaboratively develop teaching modules, and design strategies for marketing educational products. Such outcomes demonstrate not only the successful transfer of technical skills but also the cultivation of critical thinking and entrepreneurial mindset among participants.

Moreover, the program catalyzed broader social transformation within the school community. Teachers and students developed a greater awareness of the importance of technology-integrated, hands-on learning, alongside a growing spirit of school-based entrepreneurship. A significant outcome of the initiative was the formation of collaborative networks between the school and the program implementation team, aimed at sustaining the innovation beyond the project's timeframe. In conclusion, this initiative contributed not only to the enhancement of participants' microtechnical competencies but also fostered a shift in

educational perspective—positioning the school laboratory as a center for applied learning and a platform for educationally driven creative economy development.

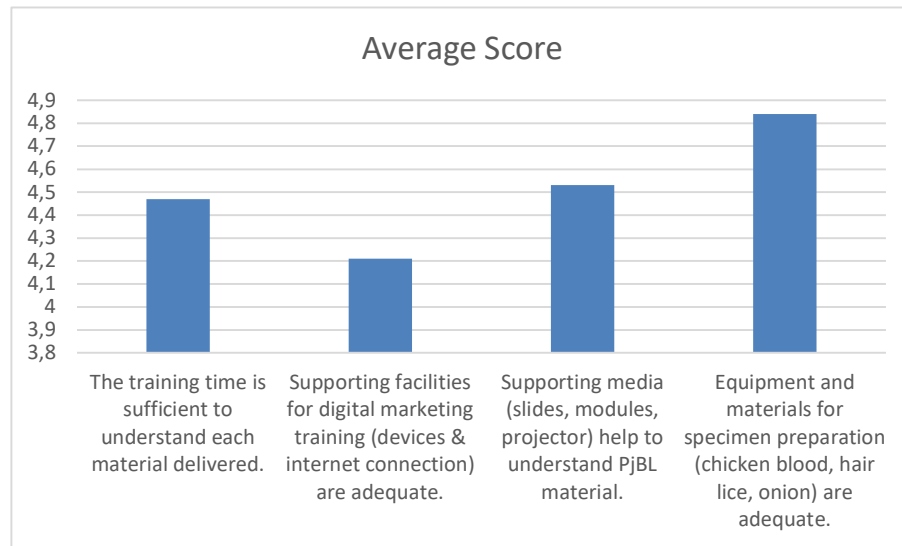


Figure 4. Results of Participant Satisfaction Survey in The Training Facilities Category.



Figure 5. Results of Participant Satisfaction Survey in The Training Usefulness Category.

4 Discussion

The implementation of the Microtechnical Skills Development Program at SMA Negeri 1 Remboken demonstrated a significant improvement in participants' competencies—both teachers and students—in understanding and applying microtechnical procedures. The average score increased from 45 in the pre-test to 72.5 in the post-test, reflecting a 61.11% improvement. This substantial gain underscores the effectiveness of the training methodology, which integrated theoretical instruction, hands-on laboratory practice, and guided assistance in developing Problem-Based Learning (PjBL)-based teaching modules. The combination of these elements contributed to enhanced comprehension and retention of both scientific concepts and pedagogical strategies, thereby equipping participants with the necessary skills for sustainable classroom implementation.

The improvement in participants' practical skills was further evidenced by the successful production of 55 microscopic slides, comprising 12 chicken blood smear preparations, 15 wholemount preparations of head lice, and 28 squash preparations of onion root tips. Of these, 37 slides were deemed suitable for commercialization as educational products (Figure 6). This outcome not only highlights the effective transfer of technical competencies but also reveals the potential for schools to engage in educational entrepreneurship. By transforming laboratory-based activities into marketable products, the program has paved the way for schools to explore creative economy initiatives rooted in science education. Such outcomes reinforce the relevance of integrating practical science learning with entrepreneurial training to promote sustainability and innovation within the educational environment. (Gouvea et al., 2021) emphasizes that integrating creative economy into education can build innovative character and independence in students from an early age.

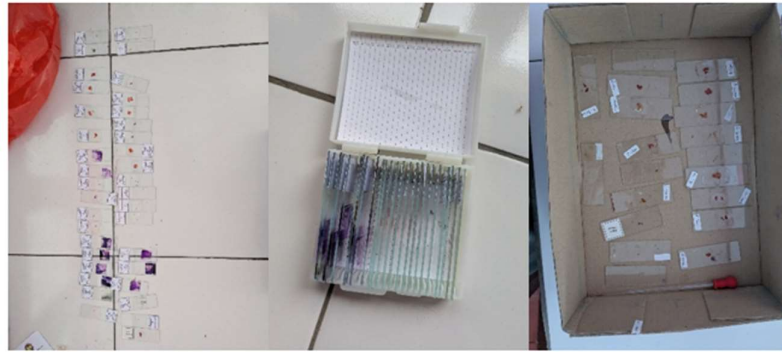


Figure 6. Whole Mount, Smear, and Squash Preparations Produced by PKM Training Participants.

The training on the squash technique, utilizing root tips of red onion (*Allium cepa*) and garlic (*Allium sativum*), successfully enhanced the skills of partner teachers and students in preparing microscope slides to observe the mitotic cell division process. The preparation of mitotic chromosome slides followed standard protocols for fixing and squashing meristematic root cells of *Allium cepa*. The procedure began with germinating onion and garlic bulbs, followed by cutting root tips of approximately 1 cm in length. These root tips were then fixed in FAA solution (Formalin–Acetic acid–Alcohol) and transferred to a watch glass for the hydrolysis process. The selection of red onion and garlic roots as biological specimens was based on their easy availability and suitability for high school biology curricula, making them ideal for practical learning activities at the secondary education level.

During the training process, participants encountered several challenges, particularly in the squashing and mounting stages of slide preparation. As this was their first experience, many participants hesitated during the squashing step due to fear of breaking the cover glass, which often resulted in uneven spreading of the root tip cells. To address this issue, participants received individual guidance and were instructed to apply pressure using the last segment of their thumb, rather than the fingertip, in order to achieve more stable and controlled pressure.

Another common difficulty emerged during the mounting process, where participants initially lacked the dexterity to properly place the cover glass, often resulting in air bubbles trapped within the slide. The

training team provided a practical solution: participants were guided to lower the cover glass at an angle of approximately 45°, allowing it to gently settle onto the preparation surface. In cases where bubbles still formed, they were taught to gently slide the cover glass or apply a small amount of Entellan mounting medium to displace the air (Riding, 2021).

After two to three rounds of supervised practice, participants showed significant improvement in their technical performance. They were able to produce mitotic preparations with well-dispersed cells that were thin, non-overlapping, and free of air bubbles. This not only reflects the effectiveness of the hands-on, mentored training, but also demonstrates the increase in participants' confidence and precision in preparing high-quality microscopic slides.

As a result of the squash technique training, participants were able to successfully observe various stages of mitotic cell division, including prophase, metaphase, anaphase, telophase, and cytokinesis. Observations were conducted using monocular light microscopes with natural sunlight as the illumination source.

The participants' success in preparing their own slides provided a meaningful and engaging learning experience, enhancing their conceptual understanding of cell division. Moreover, the ability to directly observe the mitotic phases from their own preparations significantly increased students' enthusiasm and motivation to engage in laboratory-based science learning.

The slides produced during the training clearly revealed the distinct phases of mitotic cell division, allowing participants to observe and understand each stage of mitosis directly. The visibility of cellular structures in the prepared samples enhanced comprehension of the dynamic process of cell division. Figure 7 presents examples of several mitotic phases successfully observed by the participants, including cells undergoing prophase, metaphase, anaphase, and telophase, as captured through their own microscope preparations.

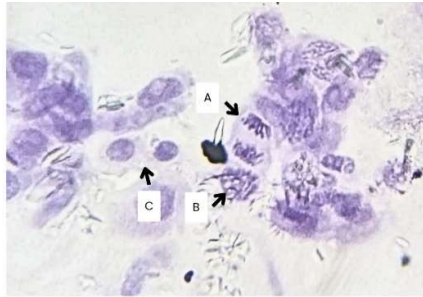


Figure 7. Squash Preparation of Onion Roots Showing A. Anaphase, B. Prophase, and C. Cytokinesis at 10x40 Magnification.

Learning mitosis through squash preparations of onion root tips at the high school level plays a crucial role in deepening students' understanding of the cell division process (Lai et al., 2024). This laboratory activity enables students to directly observe the sequential phases of mitosis—prophase, metaphase, anaphase, and telophase—thus transforming abstract theoretical concepts into tangible, contextual, and more comprehensible learning experiences.

In addition to reinforcing conceptual understanding, the activity provides hands-on training in microtechnical skills, including tissue sectioning, staining, and slide preparation. Through these procedures, students become familiar with systematic laboratory workflows and develop an appreciation for the importance of laboratory safety protocols. Such experiential learning not only enhances scientific literacy but also cultivates students' confidence in conducting experimental procedures independently.

In addition to reinforcing conceptual understanding, this activity also trains students in observational skills, precision, and analytical thinking in identifying chromosomal morphological changes during each phase of cell division. Through direct observation, group discussion, and evidence-based conclusion drawing, students are encouraged to develop a critical and reflective scientific mindset (Legare, 2025). Thus, learning mitosis using onion root squash preparations not only strengthens mastery of biological concepts, but also fosters interest in science learning and equips students with practical laboratory skills that are valuable for higher levels of education. These outcomes are consistent with findings from recent educational studies emphasizing the importance of hands-

on, inquiry-based science education in cultivating scientific literacy and student engagement (Morris, 2025).

The wholemount preparation training of animal specimens at SMA Negeri 1 Remboken began with the specimen collection and preparation phase. Each participant was instructed to bring a sample of human head lice (*Pediculus humanus capitis*) to be used as the practicum material. Following this, participants received detailed instruction on the steps for creating a wholemount slide preparation. The process commenced with fixation, in which specimens were immersed in a 10% potassium hydroxide (KOH) solution and heated at 70°C for 30 minutes. According to (Azizah et al., 2022), fixation using 10% KOH for 24 hours effectively softens and clears the insect exoskeleton, thereby facilitating the observation of internal structures. The heating and soaking process also causes the lice to lose their pigmentation or turn translucent brown, which significantly aids in the morphological identification of the preserved specimens. The more transparent the specimen, the higher the quality of morphological identification (Agustina et al., 2024).

After fixation, the specimens were transferred to a watch glass and rinsed with distilled water for 10 minutes to remove any residual KOH. They were then immersed in 10% acetic acid for 30 minutes to further aid in the softening of the exoskeleton, followed by another 10-minute rinse with distilled water. The next stage was dehydration, in which specimens were immersed sequentially in graded alcohol solutions (50%, 70%, and 96%), each for 3 minutes.



Figure 8. Treatment Process on Human Head Lice Specimens (*Pediculus Humanus Capitis*)

The next step in preparing the wholemount specimen was clearing. Participants applied clove oil to the specimen for 30 minutes, followed by gently pressing it between a microscope slide and cover glass to

eliminate air bubbles. Clove oil served to clean and clarify the specimen while preserving delicate tissues that might be damaged by harsher preservatives. Subsequently, the specimen was immersed in pure xylene for 30 minutes before being mounted on a microscope slide. In microtechnique, the use of xylene is referred to as the clearing stage, which aims to render the specimen more transparent, clean, and easier to observe under a microscope (Iswara & Wahyuni, 2019). During observation, participants continued to apply xylene to the preparation to maintain the specimen's clarity. Specimens of head lice that had the best positioning and morphology were then mounted using Entellan as the mounting medium, covered with a cover slip, and labeled according to standard procedures.

This training successfully enhanced the technical competencies of both teachers and students in various aspects, including specimen collection, preparation, and analysis techniques. The quality of the produced microscope slides served as an indicator of the training's effectiveness, showing improvements in clarity, mounting precision, and morphological detail. The resulting wholemount preparations provided a clear visual representation of insect morphology, thereby supporting more accurate microscopic analysis (Figure 9).

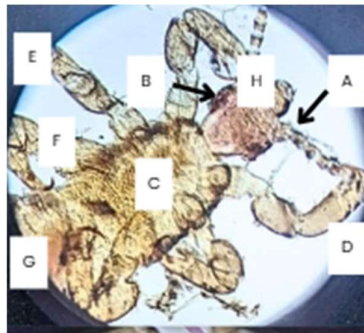


Figure 9. Preserved Specimen Of *Pediculus Humanus-Capitis*, A. Antennae, B. Eyes, C. Thorax, D. Proleg, E. Metaleg, F. Mesoleg, G. Abdomen, and H. Thorax D (5x10 magnification) Observed Using a Non-Electric Monocular Microscope.

The process of preparing a blood smear from chicken (*Gallus sp.*) begins with the collection of blood samples during the slaughtering process (Figure 9). The freshly drawn blood is immediately spread thinly

onto a glass slide to create a smear. Once the smear has dried, a dehydration process is performed by applying alcohol to the slide. The smear is then stained using Giemsa stain, with butterfly pea (*Clitoria ternatea*) flower extract applied as a natural alternative. Giemsa staining results in purplish-blue nuclei and clearly visible pink-stained leukocyte granules. Additionally, the smears demonstrate improved durability when stored after staining (Ardina & Rosalinda, 2018).

However, several participants initially encountered difficulties in producing thin and even smears, resulting in preparations with overly thick and clotted blood layers that hindered microscopic observation. This challenge was gradually resolved through direct guidance from the training team and repeated practice, which significantly improved the participants' skills in creating high-quality smears. Consequently, the training not only enhanced participants' understanding of blood smear preparation procedures but also provided practical experience in basic laboratory techniques, which are valuable for supporting biology education in schools.



Figure 10. Training Participants Conducting a Practical Exercise on Chicken Blood Smear Techniques (*Gallus* sp.).

In addition to technical skills, the program also successfully fostered entrepreneurial awareness among participants. Survey results indicated a high level of satisfaction in the categories of training content (score: 4.79), facilities (4.84), and perceived usefulness (4.58). These achievements demonstrate that a training approach combining practical laboratory competencies with digital marketing instruction yields a more comprehensive impact. This finding supports the view of Pambudi (2021), who argues that schools can function as incubators that cultivate a creative generation through the utilization of digital technology.

From a social perspective, the dynamics of the mentoring process revealed behavioral changes and increased awareness among teachers and students regarding the importance of technology-based practical learning. Participants not only acquired technical skills but also developed the ability to identify and utilize local biological resources—such as native plant materials around the school—for microtechnique practice.

5 Conclusion

The Microtechnique Competency Development Program at SMA Negeri 1 Remboken successfully enhanced the technical capabilities of both teachers and students in preparing microscopic slides. The increase in the average test scores from 45 (pre-test) to 72.5 (post-test) reflects the effectiveness of the training, which combined theoretical instruction, hands-on practice, and direct mentoring. Participants produced a total of 55 microscopic preparations, 37 of which were deemed marketable as educational products—highlighting the potential for creative economic development within the school setting. Beyond technical skill enhancement, the program also fostered awareness of the importance of utilizing laboratories as centers for innovative learning and platforms for creative enterprise development. For sustainability, continued mentoring in managing educational products, digital marketing training, and collaboration with external stakeholders is recommended to support laboratory facilities and expand marketing networks.

6 Acknowledgment

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