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Enhancing Hydrographic Surveying Skills through a Blended Learning Approach

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Abstract

In the rapidly evolving field of geomatics engineering, continuous professional development (CPD) is essential for surveying practitioners to maintain and enhance their competencies. This study discusses the integration of hybrid classroom theory lectures, hands-on laboratory training and on-site field survey practicals as a comprehensive approach to empower hydrographic surveying courses. This blended course integrates project-based learning (PBL) from project planning to final chart production, offering an authentic and collaborative educational experience. This authentic learning experience involves onboard vessel data acquisition, data processing, and charting which enhances the educational experience and prepares learners for real-world applications. Notably, it marks the first implementation of the PESISIR blended learning approach in our master's degree programme. Student evaluations demonstrated a strong satisfaction 83% overall score, 83, with particular praise for the lecturer's expertise, practical focus, and real-world applications. Quantitative results showed high attainment of learning outcomes 87% mastery in advanced hydrographic methods, 80% in data application, while qualitative feedback highlighted the value of fieldwork and requested expanded hands-on opportunities. This feedback informed iterative improvements, including enhanced field exercises and collaborative projects. In conclusion, this approach represents a significant milestone in advancing hydrographic education through a comprehensive and innovative model. By integrating onboard vessel data acquisition, data processing, and charting with a blended learning model, this initiative not only enhances practical skills but also demonstrates the adaptability of modern Technical and Vocational Education and Training (TVET) educational methods. The successful implementation of this blended program paves the way for future advancements in the field, fostering a new generation of skilled professionals in hydrography and geomatics engineering.

Keywords: Hydrographic Surveying, Blended Learning, Educational Practices

Introduction

Hydrographic surveying, also known as marine surveying, focuses on gathering hydrospatial information about the physical features of the water bodies, including water depths, seabed composition, and the location of navigation hazards. It plays an essential role in numerous applications, including maritime navigation, marine construction, environmental monitoring and offshore resource exploration (Igbinenikaro et al., 2024; Furness, 2021; Mira, 2003). As the geomatics engineering field evolves with advancements in technology, there is a persuasive need for skilled professionals capable of not only operating sophisticated hydrographic equipment but also interpreting complex data to ensure safety and efficiency in navigation and resource management. To address this need, the Technical and Vocational Education and Training (TVET) agenda has incorporated project-based learning (PBL) as a means to bridge theoretical knowledge with real-world applications. The integration of PBL has proven effective in hydrographic surveying education, enabling students to engage with real-world problems while developing both hard and soft skills (Munge et al.2018; Jones and Washko, 2022; D'Urso et al., 2023)

Traditional educational methods (Lucas & Hanson, 2016; Alzain et al., 2018; Shala et al., 2024), predominantly characterized by theoretical instruction, often fail to equip learners with the practical skills necessary to tackle real-world challenges in hydrographic surveying. Hence, innovative educational approaches that integrate both theoretical knowledge and hands-on experiences are increasingly emphasized (Carlson & Sullivan, 1999). Blended learning (Graham et al., 2013) which combining online instruction with hands-on training, has emerged as an effective pedagogical strategy in technical disciplines (Bonk & Graham, 2012; Ho et al., 2016; McCarthy & Palmer, 2023). This authentic teaching and learning approach is strategized to satisfy the needs of the industry and the profession (Laszlo & Castro, 1995). This study aims to evaluate a blended learning model for hydrographic surveying education by assessing its effectiveness in developing technical competencies, enhancing student engagement through project-based learning, bridging the gap between theoretical knowledge and practical application, establishing a replicable competency framework, and identifying opportunities to strengthen hands-on training components to better prepare students for industry demands.

Thus, this study explores the integrations of hybrid classroom theory learning, hands-on laboratory exercises and field-based practical to enhance hydrographic surveying education specifically in UTM's PESISIR. UTM PESISIR is a postgraduate weekend program that is offered off-campus to suit the working adults. The lectures are usually conducted classes during weekends or at the company training centres. The PESISIR blended learning model, implemented in UTM serves as a case study to evaluate the effectiveness of this approach. The objectives of this study are to access the impact of the blended learning on hydrographic surveying skill development; to evaluate the student engagement and competency in PBL; and to propose a workable framework for integrating blended learning in hydrographic education. Figure 1 shows an illustration of the learning components in this tailor-made blended learning and its targeted outcomes. Meanwhile, the teaching and learning efficiency is gauged as well as the current and future challenges are also discussed in this paper.

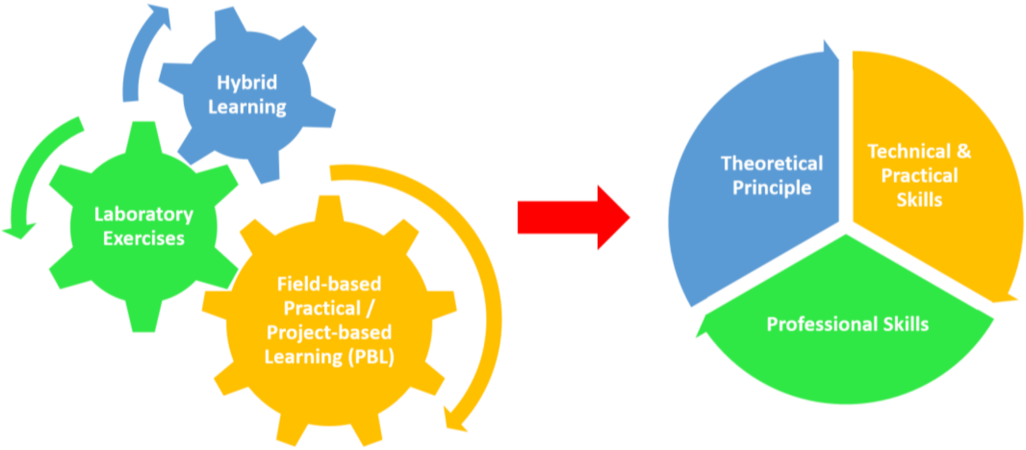

Figure 1. Learning Components and Targeted Outcomes in the Blended Learning Methodology

The Hydrographic Surveying Application (MBEE1533) course is designed to provide comprehensive knowledge of the hydrographic surveying such as hydrographic positioning, hydrographic hardware and software, automated bathymetry data acquisition, datum, tidal analysis, coastal engineering, and oceanography, roles of hydrography in offshore surveying and oil and gas industry, and also hydrographic information system. At the end of this course, all the learners will be able to distinguish the various concepts of latest measurement, techniques, and procedures of implementation hydrographic survey; solve related problem in hydrography and creatively using modern tools and techniques; assemble data obtained from hydrographic survey technology; and use systematic research methodology to the role of surveyor or hydrographer in providing quality coastal and offshore data for various activities. This paper outlines the structure, goals, and effectiveness of the MBEE1533 course, addressing its impact on learners' educational development.

Course Structure and Implementation

This tailored-made Hydrographic Surveying Application (MBEE1533) course integrates the hybrid classroom theory lectures, hands-on training and on-site PBL practical as an authentic approach to empower hydrographic education. The implementation of this MBEE1533 module consists of three primary components, namely Hybrid Learning, Laboratory Exercises and Field-based PBL throughout the 14 weeks semester period. This innovative teaching and learning (T&L) strategically designed to enhance learning outcomes with research and enquiry, allowing the learners to develop ability in investigating problems, making judgement on the basis of sound evidence, resolving problems on a rational basis and understanding the purpose of doing things.

Hybrid Learning

The hybrid learning component consists of twice online-based and a single classroom-based lectures that combine traditional instruction with online e-Learning resources (Huang et al., 2008). Figure 1 showcases the blended scheduled lectures which enable interaction between instructors and learners, allows for flexibility in learning and integrates various educational technologies to facilitate access to information. The effectiveness of an online-based lectures eliminates the need for physical travel, which saves time and reduces expenses related to transportation, accommodation, and venue bookings. In particularly beneficial to those part-

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time professional adult learners, making them easier to juggle works and studies. Besides that, recorded lectures and digital resources are a game-changer for self-paced learning. They allow learners to access to the e-Learning portal which provide the learners with the opportunity to engage with course materials asynchronously. Unlike physical classroom sessions, learners can take their time to absorb key points, rewind and rewatch the complex topics for better understanding.

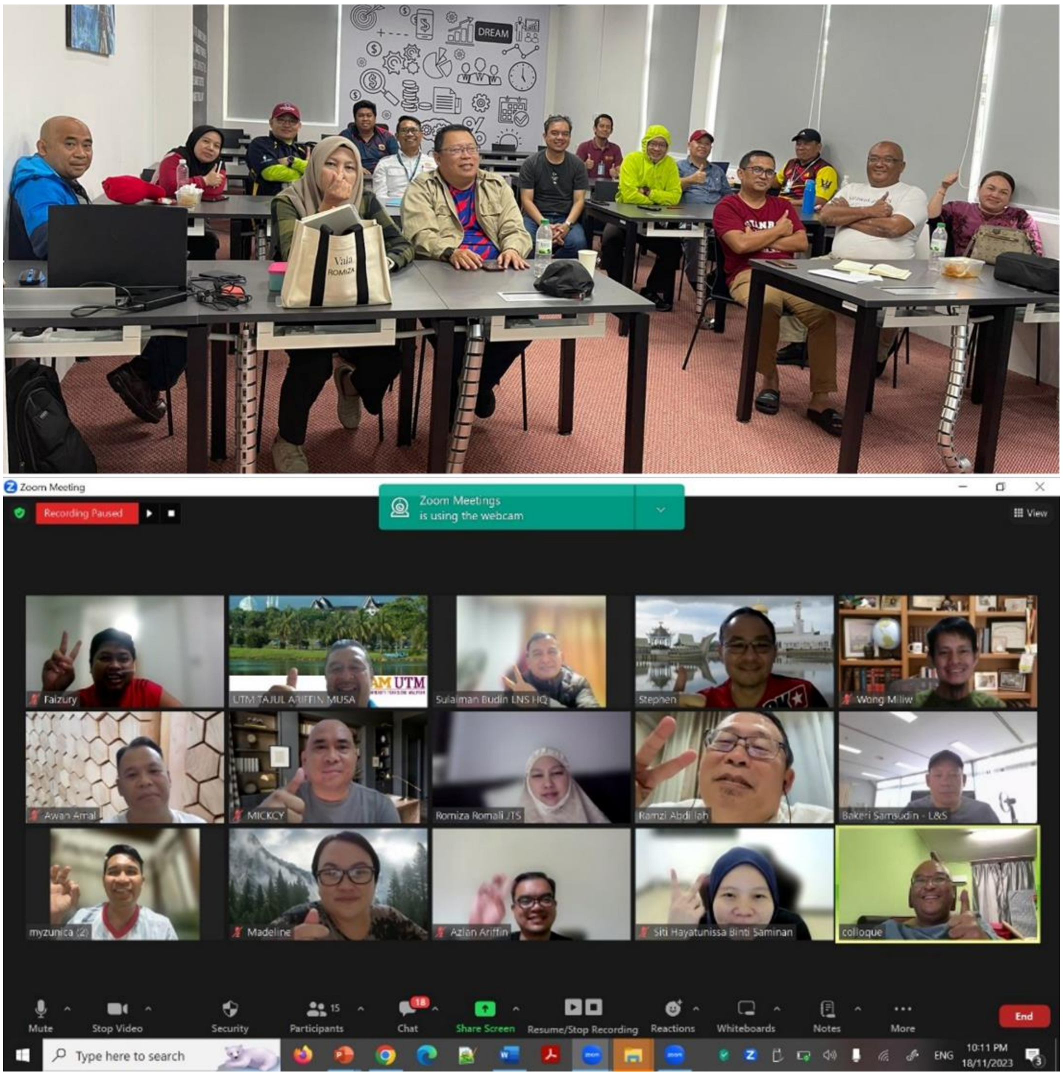

Figure 1. Online-based and Classroom-based Lectures.

Hybrid learning, which combines online flexibility with in-person engagement, is especially valuable in technical fields like hydrographic education. Research has demonstrated that hybrid learning can lead to improved student engagement and academic performance, as it allows for a more personalized learning experience (Garrison & Kanuka, 2004). Adaptive online modules allow students to master theoretical concepts at their own pace, while face-to-face enhance understanding through structured discussions, case-based problem-solving, and real-time feedback from instructors with hydrographic field experience. Indeed, this aligns with the International Hydrographic Organisation (IHO) competency standards (S-5, 2022), which emphasize both foundational knowledge and applied critical thinking. In short, this hybrid approach not only accommodates diverse learning styles but also fosters the selfdirected learning essential for hydrographic surveying professionals who must continually adapt to evolving technologies and methodologies.

Laboratory Exercises

Beyond the theoretical exposures, laboratory exercises provide hands-on training in hydrographic surveying techniques and technologies. This component serves as a critical bridge between classroom concepts and real-world application, allowing students to apply the concepts learned in lectures directly in a controlled environment. These exercises include the use of advanced surveying equipment and software applications, fostering technical proficiency and reinforcing practical skills under the technical experts' supervision. Predominantly, the learners practice tide gauge installation and tidal data processing, multibeam system's bench testing and calibration, GNSS observation techniques, and precision levelling procedures. Through structured exercises, they learn to configure survey software and process data to industry standards. These practical sessions bridge theory and practice, developing both technical proficiency and problem-solving abilities.

Figure 2. Laboratory Exercises.

The importance of laboratory-based learning has been well-documented, with studies showing that experiential learning in laboratory settings enhances comprehension and retention of complex scientific concepts (Fan, 2015). The MBEE1533 course leverages this principle by immersing students in an active learning environment where they can experiment, observe, and refine their skills. Through realistic scenarios, students learn to troubleshoot common operational challenges, preparing learners to handle real-world surveying situations with confidence and expertise. This kind of hands-on experience cultivates both technical competence and the problem-solving abilities (Marcellis, 2024) are vital for professional hydrographic work. Undeniably, this kind of experiential approach reinforces classroom learning while preparing students for real-world surveying challenge.

Field-based Problem-Based Learning (PBL)

Field-based problem-based learning (PBL) forms the foundation of the MBEE1533 course, immersing students in authentic hydrographic surveying projects that mirror real-world professional challenges (Figure 3). Through collaborative fieldwork, students actively engage in solving complex, practical problems that require them to apply theoretical knowledge while developing critical thinking and analytical skills essential for the profession. This hands-on approach not only reinforces the technical competencies gained during laboratory sessions but also cultivates vital soft skills including effective teamwork, clear communication, and sound decision-making under field conditions.

Figure 3. Field-based Problem-Based Learning activities.

The effectiveness of this pedagogical approach is well-supported by educational research, particularly in Barrows (1986) demonstrating how problem-based learning enhances higher-order cognitive abilities and promotes deeper subject matter understanding. By situating learning in actual field environments, the course creates powerful experiential opportunities where students must continuously adapt and synthesize classroom theory with practical application. As they navigate authentic challenges such as equipment limitations, environmental variables, and data quality issues, students develop the adaptive problem-solving skills and professional judgment needed to excel in hydrographic surveying careers. This comprehensive field-based PBL approach ultimately produces work-ready graduates capable of handling the full spectrum of surveying tasks, from project planning and equipment deployment to data collection, processing, and quality assessment.

Emphasizing Practical Competencies in Hydrographic Training

The changing dynamics of the global workforce, propelled by rapid technological advancements and evolving market demands, necessitate a reassessment of educational frameworks (Furness, 2021). Traditional pedagogical methodologies, which prioritize theoretical knowledge and exam-oriented assessments, may not equip students with the practical competencies required to thrive in contemporary work environments. In the light of the continuous evolving technology, there is a continuous need for up-to-date teaching and learning methods (Yunus et al., 2024). This initiative highlights a forward-thinking approach to Technical and Vocational Education and Training (TVET) by merging hands-on experience with theoretical knowledge, to bridge the gap between classroom theory and real-world application. Hence, graduates gain job-ready skills aligned with Industry Revolution 4.0 (IR4.0) standards making them valuable assets in data-driven hydrographic surveying operations.

Figure 4. Hydrographic Field Practical at Forest City, Johor Bahru.

In this MBEE1533 program, it incorporates a 2 days tailor-made hydrographic field survey practical (Figure 4), where students apply their classroom and laboratory knowledge in a real-world on-the-job training scenario. By engaging in hands-on data collection, processing, and analysis, trainees develop critical technical and problem-solving skills essential for hydrographic surveying. This experiential learning approach ensures that theoretical concepts are reinforced through practical application, preparing students for the demands of the industry. The exercise simulates actual fieldwork conditions, requiring trainees to operate survey equipment, collect data, process data and produce precise and accurate hydrographic information plan (Figure 5), which mirroring the challenges they will face in professional settings. Through this immersive training, students not only refine their technical abilities but also cultivate teamwork, adaptability, and decision-making skills. By bridging the gap between academia and industry, this program equips graduates with the confidence and competence needed to excel in hydrographic careers, ensuring they are job-ready from day one.

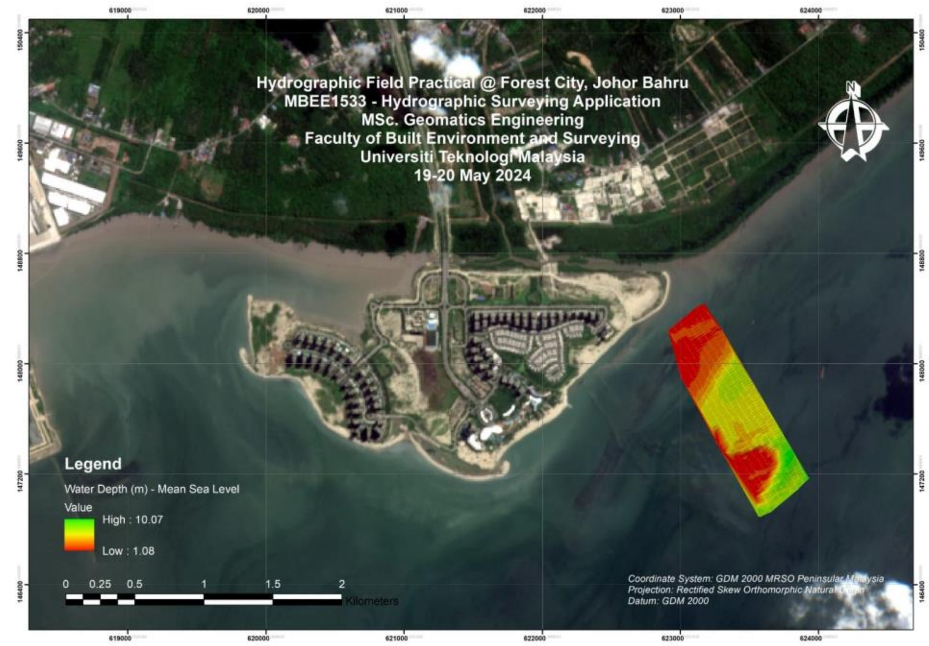

Figure 5. Hydrographic Information Plan at Forest City, Johor Bahru.

In order to ensure long-term success, strong partnerships with corresponding Government agencies such as National Hydrographic Centre (PHN), Department of Survey and Mapping Malaysia (JUPEM), Land and Survey Department Sarawak (JTS), Marine Department of Malaysia (JLM), etc. as well as the respective industrial players providers will keep training programs aligned with the latest industry innovations. A well-designed educational approach would help in align workforce skills with global environmental goals by producing a skilled workforce for the hydrographic surveying industry. In short, future training should emphasize practical competencies, not just theoretical knowledge or the traditional exam-oriented approach, particularly in critical areas such as hydrographic education.

Student Feedback and Evaluation

The course evaluation, based on feedback from 13 of 15 enrolled students, revealed strong satisfaction with the lecturer's teaching methods and course structure. The overall satisfaction score was 5.76 out of 6 (83%), indicating a highly positive response. Key strengths included the lecturer's ability to deliver knowledge effectively, with 92% of students rating the course design and organization highly at 5-6 out of 6. Additionally, 96% praised the facilitation and implementation of the course, highlighting the practical sessions as particularly valuable for understanding complex hydrographic concepts.

On the other hands, the Course Assessment Report (CAR) also demonstrated strong attainment of learning objectives. 87% of students successfully classified advanced hydrographic methods (CLO1), while 74% could construct solutions for surveying practices (CLO2). Additionally, 80% effectively applied hydrographic data for system development (CLO3), showcasing the course's alignment with industry-relevant skills. Programme outcomes (PO) were also met, with 87% mastery in geomatic engineering knowledge (PO1) and 90% proficiency in problem-solving (PO6). However, practical skills (PO2) scored slightly lower (75%), suggesting a need for more hands-on training.

The course achieved high satisfaction and learning outcomes, with minor refinements needed in practical training. By integrating more experiential learning, future iterations can further bridge theory and real-world application, ensuring continued success. Students suggested enhancements included more fieldwork (e.g., multibeam bathymetry surveys, side scan sonar, etc.) and more practical time for hands-on data processing. By integrating more experiential learning, future iterations can further bridge theory and real-world application, ensuring continued success.

Challenges and Periodic Course Review
Recent advancements in hydrographic surveying technologies, such as the use of Unmanned Surface Vehicles (USVs) and automated procedures, highlight the significance of integrating practical training into educational curricula. For instance, USVs have proven to provide distinct advantages in conducting surveys in hard-to-reach water bodies, facilitating tasks such as the development of navigational and bathymetric charts (Specht et al., 2020). Furthermore, automation in data review processes enhances the quality and timeliness of hydrographic surveys, allowing practitioners to build confidence in the final data despite being in training roles (Chénier, 2018). Such integration of technology indicates the necessity for educational programs to incorporate training with modern tools to adequately prepare learners for the evolving demands of the industry (Widodo et al., 2019).

Moreover, the challenges faced in hydrographic surveying, including ensuring navigational safety and efficient resource management, necessitate ongoing assessment and adaptation of educational programs. Research emphasizes the importance of training on the application of Geographic Information Systems (GIS) in hydrographic surveys, which can help prioritize survey efforts and enhance data accuracy (Chénier et al., 2018). By implementing inter- and multi-disciplinary training curriculums that expose learners to a variety of methodologies and technologies, educational institutions can better prepare graduates to meet the complexities of real-world hydrographic tasks (Duan et al., 2021; Yang et al., 2023).

Furthermore, case studies and training programs exemplify the importance of practical experience in education. For instance, the COMREN initiative in Canada aims to develop research activities and educational programs that foster close interactions with professionals and stakeholders in the hydrospatial field (Daniel et al., 2022; Tang et al., 2025). Similarly, international cooperation in training programs, such as those offered through the Erasmus initiative, emphasizes the value of experiential learning and knowledge exchange among learners from diverse educational backgrounds (Seube, 2012). In summary, the hydrographic surveying field is poised for transformation through innovative educational strategies that marry theoretical foundations with practical experiences. Institutions must continuously evolve to ensure that learners are well-equipped to navigate the complexities of hydrographic surveying in a technology-driven environment (Wulf, 2015; Tang et al., 2019; Bräker et al., 2022).

Discussion
Hydrographic surveying education must evolve to meet the demands of a rapidly advancing industry, where technological innovation and practical competence are paramount. This study demonstrates the effectiveness of UTM PESISIR's incorporating competency-based blended learning model in bridging the gap between theory and real-world application,

equipping students with the technical proficiency, problem-solving skills, and adaptability required in modern hydrographic practice. By integrating hybrid classroom instruction, hands-on laboratory exercises, and field-based problem-based learning (PBL), the MBEE1533 course ensures that graduates are not only knowledgeable but also job-ready, capable of handling complex surveying challenges with confidence.

The success of this approach lies in its alignment with industry standards, such as the International Hydrographic Organization (IHO) competencies, and its responsiveness to workforce demands. However, sustaining this progress requires continuous collaboration with government agencies, industry partners, and academic institutions to keep curricula updated with emerging technologies like unmanned surface vehicles (USVs) and AI-driven data processing (Azziddin et al., 2024). Future efforts should also emphasize interdisciplinary training, sustainability practices, and global knowledge exchange to prepare hydrographers for the challenges of tomorrow.

Ultimately, this model serves as a blueprint for modernizing hydrographic education, proving that when theory meets hands-on experience, students emerge as skilled professionals ready to contribute to safe navigation, marine resource management, and the sustainable development of our oceans. The lessons learned from UTM's program can inspire similar reforms in technical and vocational education worldwide, ensuring that the next generation of hydrographic surveyors is equipped to navigate both the seas and the future of the profession.

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