

Developing 'The Electronic Senses': An Innovation on Micro-Credential Design and Implementation using Moodle

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Abstract

The educational landscape is rapidly evolving, with a growing emphasis on lifelong learning. Micro-credentials (MCs) have emerged as a significant innovation, yet novice learners often struggle with unstructured online content. Addressing this, this paper presents a descriptive case study of 'The Electronic Senses,' an innovative MC that provides a structured, beginner-friendly gateway to foundational sensor technology. Delivered via Moodle at a Malaysian polytechnic, the development was guided by the ADDIE model, chosen for its systematic approach to documenting the development process, and aligned with the PolyCC Micro-Credential Guidelines, valued for their practical SLT framework. Key findings reveal that the SLT structuring directly shaped a more engaging design by compelling the inclusion of diverse activities. The study also affirms the sufficiency of Moodle's native tools (e.g., Lesson, H5P, Database) for creating interactive MCs without reliance on external applications. This case study serves as a replicable model for MC development within the Malaysian TVET context, offering transferable insights on operationalizing national digital education policies.

Keywords: *Micro-Credentials, Moodle, ADDIE Model, Instructional Design, Sensor Technology, TVET, Malaysian Higher Education*

1.0 Introduction

The contemporary educational landscape is undergoing significant transformations driven by technological advancements and the demand for lifelong learning (Vonitsanos et al., 2024). In this context, Micro-Credentials (MCs) have emerged as a pivotal innovation, offering focused and flexible learning avenues (Gamage & Dehideniya, 2025). This paper details the design and development of 'The Electronic Senses,' an MC on foundational sensor technology delivered via Moodle, contextualized within Malaysia's strategic push for digital education.

This initiative aligns with key national policies. These include the National e-Learning Policy 2.0 (DePAN 2.0), which provides a strategic framework for digital ecosystem development; the Malaysia Education Blueprint (Higher Education) 2015-2025, which advocates for globalized online learning (Shift 9); and the PolyCC Transformation Framework 2023-2030, which emphasizes producing an industry-ready workforce through digital learning. 'The Electronic Senses' MC supports these goals and adheres to the PolyCC Micro-Credential Implementation Guidelines (2023 Edition) to ensure quality.

The pedagogical rationale for this MC arises from the challenge novices face with unstructured online information, which can cause cognitive overload (Kassab et al., 2020). To counter this, the MC adopts microlearning principles, delivering knowledge in short, focused units to reduce cognitive strain (Marcelle, P., & Brahim, A., 2023). By breaking down sensor technology into five sequential modules (heat, light, pressure, motion, humidity), it provides a curated, scaffolded pathway for learners.

This paper has three main objectives: (1) To detail the MC's development process using the ADDIE model as a framework; (2) To identify key implementation factors including the application of PolyCC guidelines, pedagogical choices, and challenges; and (3) To disseminate key insights and recommendations for future MC initiatives

2.0 Methodology

This study employed a descriptive case study approach to provide an in-depth understanding of the design, development, and initial implementation of 'The Electronic Senses' MC within its real-life context at Politeknik Sultan Mizan Zainal Abidin (PSMZA). The design and

development process followed the five phases of the ADDIE model, integrating adherence to the PolyCC Micro-Credential Guidelines through detailed SLT planning.

2.1 Analysis Phase

This phase involved needs assessment, problem identification (lack of structured sensor knowledge for non-electrical engineering students), target audience analysis (public and PolyCC beginners), and scope determination (five fundamental sensor types), aligning with the 40-hour Student Learning Time (SLT) stipulated by PolyCC Guidelines.

2.2 Design Phase

The MC was structured as a 40-hour SLT, beginner-level, free English course with a certificate, comprising an Introductory Module, five Core Content Modules (*Moodle Lesson* + *H5P CA* each), and Concluding Activities, with enforced sequential learning (see Figure 1). Key specifications included:

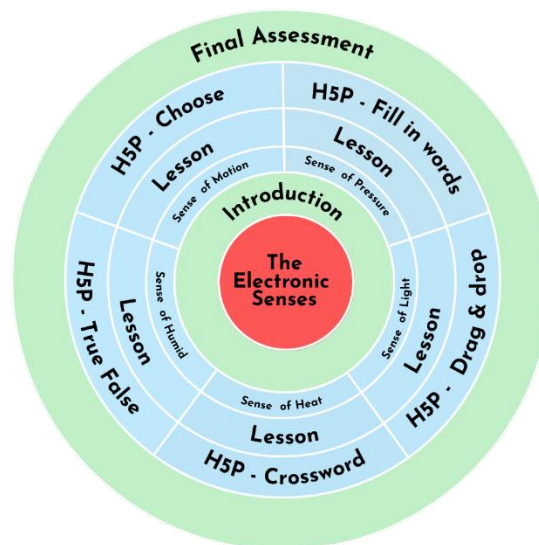


Figure 1: Conceptual Map of the Instructional Design for 'The Electronic Senses' Micro-Credential.

- **Platform and Tools:** The course was developed on Moodle, justifying its selection as it is freely available and institutionally supported. Key features leveraged include completion tracking and conditional activities to enhance learner engagement (Wambua & Maake, 2021), H5P for interactive assessments, and the automated awarding of certificates and badges.
- **Course Structure:** The course was structured to guide learners sequentially, beginning with an introductory module that oriented participants using a *Page* for instructions, a *Chat* for questions, a *Database* for a creative ice-breaker (see Figure 2), and an embedded video. This was followed by five core content modules (heat, light, pressure, motion, humidity) presented using the *Lesson* tool. Each module, containing slides, videos, and 'pop quizzes' to retain focus (Carrión, 2022), was scaffolded through a uniform structure and an enforced sequential path to ensure progressive learning (see Table 1 and Figure 3). Integral to this structure was a three-tiered assessment strategy, comprising formative "pop quizzes" within each Lesson, a summative continuous assessment (CA) via a different H5P activity for each module (see Figure 4), and a final summative assessment using the Moodle Quiz tool. A certificate of completion was awarded upon successful

completion of all activities, which required meeting conditions such as achieving a passing score.

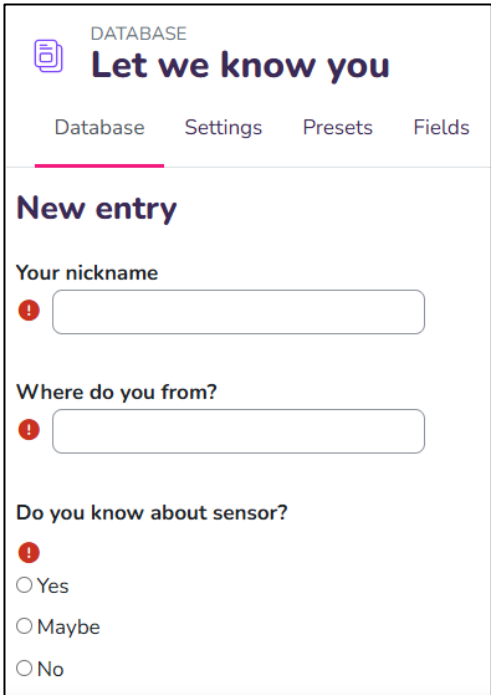


Figure 2: Screenshot of the Database activity configured as an ice-breaker.

Editing lesson		
Page title	Page type	Jumps
Pressure sensor	Content	Next page
Introduction	Content	Previous page Next page
Video - How pressure sensor works	Content	Previous page Next page
Pop quiz 8	Matching	Next page Previous page
Piezoresistive	Content	Previous page Next page
Capacitive	Content	Previous page Next page
Video - Capacitive	Content	Previous page Next page
Pop quiz 9	True/false	Next page Piezoresistive
Vibrational resonance	Content	Previous page Next page
Micro Electro Mechanical System	Content	Previous page Next page
Fiber optic	Content	Previous page Next page
Magnetic	Content	Previous page Next page
Diffusion	Content	Previous page Next page
Pop quiz 10	Multichoice	Diffusion Magnetic Fiber optic Next page
End of lesson	Content	End of lesson Pressure sensor

Figure 3: Example of an integrated Moodle Lesson showing slides, video and a pop quiz

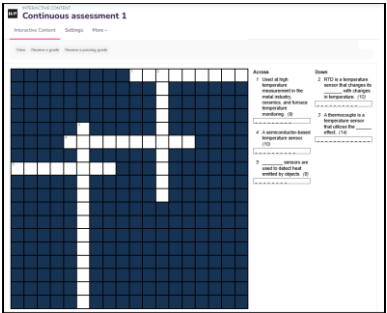


Figure 4: Example of an interactive H5P (Crossword) used for continuous assessment.

Table 1: Breakdown of Student Learning Time (SLT) for 'The Electronic Senses' MC

Module	Type of Content	Guided Learning (minutes)	Independent Learning (minutes)	SLT (minutes)
Introduction	Page, Chat, Database, Video			180
Sense of Heat	Lesson - Slide	40	0	40
	Lesson - Video 1	60	120	180
	Lesson - Video 2	60	120	180
	Lesson - Pop Quiz	7	14	21
	H5P (Crossword) - Continuous Assessment (CA)	5	20	25
Sense of Light	Lesson - Slide	50	0	50
	Lesson - Video 1	30	60	90
	Lesson - Video 2	30	60	90
	Lesson - Video 3	60	120	180
	Lesson - Pop Quiz	6	12	18
Sense of Pressure	H5P (Drag & Drop) - CA	5	20	25
	Lesson - Slide	40	0	40
	Lesson - Video 1	60	120	180
	Lesson - Video 2	60	120	180
	Lesson - Pop Quiz	5	10	15
Sense of Motion	H5P (Fill in words) - CA	5	20	25
	Lesson - Slide	35	0	35
	Lesson - Video 1	60	120	180
	Lesson - Video 2	60	120	180
	Lesson - Pop Quiz	6	12	18
Sense of Humidity	H5P (Choose) - CA	5	20	25
	Lesson - Slide	35	0	35
	Lesson - Video 1	30	60	90
	Lesson - Video 2	30	60	90
	Lesson - Video 3	30	60	90
	Lesson - Pop Quiz	4	8	12
	H5P (True False) CA	5	20	25
	Quiz - Final Assessment	20	80	100
TOTAL				2400

2.3 Development Phase

This phase involved creating learning materials (Canva slides, AI-assisted assessment items, curated YouTube videos) and constructing the course in Moodle, which included configuring all tools and enforcing the sequential learning path.

2.4 Initial Implementation Phase

An initial pilot test was conducted with seven volunteer PSMZA students to evaluate the course flow, identify technical issues, and gather direct, unstructured feedback via text messages and verbal debriefings. All pilot users successfully completed the MC.

2.5 Initial Evaluation Phase

Evaluation involved tracking learner progress via Moodle's activity completion report, which was configured with the 'Restrict Access' feature requiring an 80% passing mark on continuous assessments before unlocking subsequent content.

3.0 Data and Analysis

Data analysis involved an integrative approach where sources were not equally weighted. Documentary evidence (e.g., PolyCC Guidelines, SLT plans) and course artifacts served as primary data, providing an objective account of the plan and its outcome. In contrast, retrospective reflections and informal pilot feedback were treated as supplementary data to contextualize design decisions and challenges. The data was analyzed qualitatively through a narrative synthesis organized by the ADDIE model's phases. Furthermore, a formative analysis of the pilot feedback revealed three key themes: navigational clarity, content readability, and minor technical glitches. The feedback predominantly highlighted minor usability issues (e.g., a confusing link, typos), which were rectified, with the absence of major conceptual flaws suggesting strong initial content validity.

4.0 Findings of the Study

4.1 Findings from the Analysis Phase

The Analysis phase confirmed a learning need for foundational sensor knowledge among non-electrical engineering students for their IoT projects, driven by scattered online resources. The target audience was finalized as these students and the general public new to sensors, positioning the MC as a "gateway" to IoT. The scope was defined as five fundamental sensor types (heat, light, pressure, motion, humidity) for their practicality, with a 40-hour SLT deemed feasible for beginners per PolyCC guidelines.

4.2 Findings from the Design Phase

The S.M.A.R.T. overall Learning Outcome was finalized: "At the end of this course, learners will be able to: Identify and describe the basic functions of five types of sensors used in daily applications". The MC was structured as a 40-hour SLT, beginner-level, free course with a certificate, utilizing Moodle tools such as Lesson, H5P, Quiz, Database, Page, Feedback, and Certificate. A three-tiered assessment strategy (Pop Quizzes, H5P CAs, Moodle Quiz FA) was finalized alongside a minimalist approach to the user interface (UI) design. This 'minimalist' approach refers to a clean visual layout and a straightforward, sequential structure, aimed at reducing extraneous cognitive load so novice learners can focus entirely on the technical content.

4.3 Findings from the Development Phase

During the development phase, several challenges were encountered, particularly the time-consuming nature of content creation and the need to simplify technical language for a

novice audience. To mitigate these, a set of practical and efficiency-focused strategies were implemented. For slide creation, a rapid selection process was utilized within Canva, using keywords like 'education' and 'minimalist' to find suitable, topic-appropriate templates efficiently. The video curation process was streamlined through a two-step method: employing a standardized search query (e.g., "how [sensor name] works") on YouTube, followed by filtering results against strict criteria including video duration, subtitle accuracy, and channel authority. Furthermore, the assessment drafting workflow was significantly accelerated by using an AI assistant to generate initial questions from video transcripts, which were then meticulously vetted and refined by the subject matter expert. This AI assistant was also instrumental in simplifying complex technical language from source materials into explanations that were more accessible to the target audience. These systematic workflows were crucial in effectively managing the development timeline and other challenges, such as the trial-and-error process of optimizing Moodle's content layout

4.4 Findings from the Initial Implementation Phase

An initial pilot test was conducted with a purposive sample of seven volunteer PSMZA students. The primary objectives were to evaluate the course's navigational flow, identify any technical issues, and gather initial user feedback on clarity and usability. Participants were given one week to complete the MC at their own pace. Feedback was collected through unstructured, direct communication, where participants were encouraged to report any issues or provide suggestions immediately via text messages or brief verbal debriefings with the researcher. The collected qualitative feedback was then analyzed thematically to generate user feedback metrics. Key metrics included the frequency and type of issues reported, which were categorized into themes such as 'navigational clarity,' 'content readability (typos),' and 'technical glitches.' All seven pilot users successfully completed the MC, indicating positive initial usability.

4.5 Findings from the Initial Evaluation Phase

Formative evaluation based on pilot feedback led to the identification and rectification of a Moodle Lesson navigation error, while the completion data from the pilot group (7) served as a positive indicator of the MC's usability. A formal Moodle Feedback survey was deployed for future evaluation, though its specific data was not analyzed for this paper.

5.0 Discussion

The study successfully achieved its objectives by demonstrating the guideline-driven (JPPKK via SLT) and ADDIE-structured development of 'The Electronic Senses' on Moodle. It identified pedagogical considerations, specific Moodle integrations (proving Moodle's native sufficiency), and challenges, thereby offering practical lessons. The project confirmed the feasibility of applying JPPKK's SLT guidelines. Key innovations included maximizing Moodle's native tools (Lesson, H5P, and Database for ice-breaking), showcasing their potential for creating rich MCs, which is particularly relevant for the PolyCC context. 'The Electronic Senses' effectively addressed the identified need for a structured, beginner-friendly introduction to sensor technology, with initial completions suggesting its usability.

The development of 'The Electronic Senses' aligns with literature definitions of MCs (e.g., 40-hour SLT, focused skills) and serves as an enabler for further learning. The application of the ADDIE model, particularly its analysis phase, proved valuable. The versatile use of Moodle's native tools was affirmed and particularly through the innovative application of the Database activity. This tool served a dual pedagogical purpose beyond a simple ice-breaker. It fostered learner interaction by allowing participants to view each other's entries, and it functioned as a pre-course diagnostic tool to gather data on learners' prior knowledge.

Development challenges, such as the time-consuming nature of iterative Moodle layout design and the learning curve associated with advanced Moodle tools like Lesson and H5P, were significant but crucial for pedagogical benefits. A key lesson learned was the importance of meticulous pre-checking of materials before Moodle integration. These challenges may be common in PolyCCs due to varying levels of familiarity with advanced Moodle features; this case study can serve as a demonstrative example.

Practically, this study demonstrates to PolyCC educators that JPPKK's SLT guidelines are viable and Moodle's native tools are sufficient for creating engaging MCs. It suggests a need for PolyCCs to disseminate good practices in MC development. For learners, such MCs can act as gateways to advanced fields like IoT. Theoretically, this study provides a contextualized example of applying the ADDIE model to policy-guided MC development and adds empirical insights into MC implementation in Malaysian TVET.

Limitations of this study include its nature as a single case study at PSMZA, potentially limiting generalizability. However, while findings may be context-bound, the study's methodology, particularly the application of PolyCC guidelines and Moodle's native tools, offers transferable insights and a replicable model for other Malaysian TVET institutions. The primary author's dual role as developer and researcher introduces potential subjectivity. The evaluation reported is primarily formative and does not provide an in-depth analysis of learning outcomes. Furthermore, the MC's focus on foundational technical concepts for beginners means findings might differ for other MC types or advanced levels.

6.0 Conclusion and Recommendations

This paper has meticulously documented the innovative design, development, and initial implementation of 'The Electronic Senses,' a micro-credential developed at PSMZA using Moodle. The primary aim was to comprehensively document this MC's creation through a descriptive case study structured by the ADDIE model, a process undertaken while adhering to institutional guidelines and leveraging platform capabilities. The development journey yielded two significant findings: the PolyCC guidelines provide a practical framework for SLT structuring that can shape a more engaging course design, and Moodle's native tools are sufficient for creating comprehensive, interactive MCs without external applications.

Based on this case study, several recommendations are proposed:

- **For Course Development:** It is recommended to institute bi-annual content reviews using specific criteria, such as verifying technological currency, checking external links, analyzing learner feedback from the integrated Moodle Feedback survey, and consulting with industry experts.
- **For Future Research:** Future research should evaluate the MC's effectiveness on learning outcomes, investigate actual SLT utilization compared to planned estimations, and include more documented case studies across various disciplines.
- **For Institutional and Policy Levels:** Institutionally, it is crucial to invest in ID capacity building through targeted professional development on both pedagogical principles (e.g., ADDIE) and advanced technical skills (e.g., H5P), complemented by establishing ID support units and fostering a community of practice.

Implementing these recommendations will significantly contribute to strengthening MC initiatives, supporting educator capacity, and enriching learning experiences within Malaysia's TVET and higher education landscape. In the long term, these enhancements are poised to improve learner employability through targeted, industry-aligned skill development, and bolster the institutional reputation of PolyCCs as agile and responsive educational providers.

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