CHAPTER I

INTRODUCTION

1.1 Background

Education is a learning process that helps students understand, think critically, and develop toward maturity (Rahman et al., 2022). This aligns with Article 31 of the 1945 Constitution, which affirms every citizen's right to obtain education and the government's obligation to organize a national education system to enhance the nation's intellectual life. Furthermore, Law No. 18 of 2002 concerning the National System of Research, Development, and Application of Science and Technology emphasizes the importance of mastering and developing science and technology as part of national development. Thus, education is not merely the provision of information or skills, but rather an effort to develop individual potential, needs, and abilities to achieve satisfying personal and social life. Its function is not only to prepare for the future but also to support students' current development. However, some students still have not achieved learning objectives, making it necessary to innovate teaching strategies to optimize learning outcomes (Rahmi & Azra, 2023). In the 21st century, educational challenges have become increasingly complex alongside rapid technological advancement and global competency requirements. Students are expected to possess critical thinking, creative, collaborative, communicative skills, as well as digital literacy. Therefore, learning must be designed not only to emphasize cognitive aspects but also to integrate innovation, creativity, and problem-solving so that knowledge can be applied in real life (Karimah et al., 2025).

In science education, chemistry holds a central role because it studies matter and its constituent substances, including their identification, properties, and methods of synthesis. As a fundamental science, chemistry is not only vital on its own but also supports other disciplines such as biology, geology, and physics, making it a foundational pillar in mastering science (Dewi et al., 2024). However, chemistry learning in schools still tends to focus on memorizing concepts and formulas, making it difficult for students to connect the material with everyday life and resulting in suboptimal conceptual understanding (Treagust et al., 2018).

The current paradigm of chemistry education requires students not only to master verbal concepts but also to think critically, solve problems, and apply their knowledge in real-life situations (Yeni et al., 2024). Therefore, teachers need to design learning experiences that consider students' prior knowledge, represent chemical phenomena meaningfully, and relate material to daily experiences to make learning more meaningful (Treagust et al., 2018).

One of the chemistry topics often considered difficult by students is thermochemistry because its concepts are abstract, involve numerous calculations, and demand a deep understanding of energy changes in chemical reactions. These difficulties often cause students to misuse formulas or fail to connect them with underlying concepts, which can lead to misconceptions (Habiddin et al., 2021; Agustina et al., 2023; Rahmi & Azra, 2023; Yeni et al., 2024). A study at SMA Negeri 8 Palu found that 60% of students experience difficulties, with the highest error rates occurring in compound heat calculations (92%) and enthalpy change calculations (93%), due to both technical and learning process challenges (Agustina et al., 2023).

Chemistry learning at the secondary level faces significant challenges, particularly in presenting abstract material that requires computational skills. Based on an interview a Chemistry teacher at SMAN 2 Medan, students still struggle to understand calculation-based materials such as stoichiometry and reaction concepts. This situation aligns with the characteristics of thermochemistry, which requires not only conceptual understanding of energy in chemical reactions but also analytical and computational precision. The strategies commonly employed of lectures, quizzes, and problem-solving exercises using slides or whiteboards, though somewhat helpful, have not yet fully succeeded in boosting student motivation and comprehension, especially since the learning materials used are mostly limited to textbooks and worksheets. As a result, students' engagement tends to decline when instruction relies solely on conventional resources. This highlights the need for more interactive and contextual learning materials that bridge thermochemical concepts with real-life applications.

With rapid technological growth in the Fourth Industrial Revolution era, digitalization has become a key solution as digital disruption transforms how people communicate, learn, and think (Dewi et al., 2021). In education, technology enriches learning methods, boosts interaction with materials, and nurtures creativity, collaboration, and applied literacy (Dewi et al., 2021). Students needs immersive, tech-based learning that connects abstract ideas to real-life contexts. Effective materials should present clear concepts while engaging students through inquiry, collaboration, and real-world relevance (van Dulmen et al., 2023). A promising innovation is the electronic module (e-module) an interactive tool that supports independent learning (Karimah et al., 2025). Studies show e-modules enhance chemistry understanding crucial to everyday life (Dewi et al., 2022), offering flexible access while promoting responsible technology use (Waluya et al., 2022). Their strength lies in accessibility across devices and the integration of text, visuals, audio, video, and animation (Erna et al., 2021; Dewi et al., 2024). Beyond capturing attention, e-modules foster motivation, deeper understanding, critical thinking, and autonomy (Abidin & Walida, 2019; Pratiwi et al., 2021). For educators, they're creative tools to deliver meaningful learning that fits the spirit of the Fourth Industrial Revolution (Zakiyah & Sudarmin, 2022). Even abstract chemistry concepts like acids, bases, and reactions can be visualized clearly for better understanding (Khlifi & El-Sabagh, 2017; Purnamasari et al., 2020).

Furthermore, e-module based learning can be combined with Higher Order Thinking Skills (HOTS) instruments. Research shows that HOTS are crucial for preparing students to face 21st-century challenges. HOTS encompass the abilities to analyze, evaluate, and create; skills that go beyond remembering or understanding concepts. In chemistry education, mastering HOTS enables students to think critically, logically, and creatively when solving problems related to chemical phenomena around them (Adella et al., 2024; Nasution et al., 2025). Modern education emphasizes developing HOTS so students can adapt to real-world issues through analysis, evaluation, and knowledge creation rather than rote memorization (Hakiki et al., 2021; Yudha, 2023; Fadia & Suartini, 2024). Recent studies have shown that using HOTS-based chemistry modules can improve student learning outcomes, with an n-gain score of 0.372 (medium category), and help them gain a deeper conceptual understanding of thermochemistry compared to conventional teaching methods (Nasution et al., 2025).

In addition to being HOTS-based, another relevant model to enhance student learning quality is discovery learning. This student-centered model aims to build knowledge through six systematic stages: (1) stimulation, (2) problem identification, (3) data collection, (4) data processing, (5) verification, and (6) generalization or conclusion drawing (Ilmi, Soekamto, & Astina, 2022). In its application, students are encouraged to find concepts through questioning, discussion, analysis, and inference, while the teacher acts as a facilitator (Sepdyastutik, 2022; Hasanah & Prayogo, 2023). Discovery learning makes lessons more meaningful, motivating, independent, and curiosity-driven, cultivating both initiative and confidence. Its advantages include greater student activity, deeper material comprehension, knowledge transfer ability, and contextual learning (Ilmi et al., 2022; Hasanah & Prayogo, 2023). A study at SMAN 3 Malang demonstrated that discovery learning enhances critical thinking skills and receives positive student feedback, underscoring the importance of selecting appropriate learning models (Ilmi et al., 2022).

Based on the discussion above, the **“DEVELOPMENT OF E-MODULE BASED ON HIGHER ORDER THINKING SKILLS (HOTS) INTEGRATED WITH DISCOVERY LEARNING FOR THERMOCHEMISTRY MATERIAL”** is highly necessary. This e-module serves not only as a flexible and practical learning resource but also as an effective tool for fostering higher-order thinking skills. The integration of HOTS with discovery learning is expected to help students develop a deeper understanding of thermochemistry concepts, improve learning outcomes, and better prepare them for the challenges of 21st-century education. This research is expected to make a meaningful contribution to improving the quality of chemistry learning through digital technology utilization and innovative instructional approaches.

1.2 Problem Identification

Based on the background description, several problems can be identified as follows:

1) The chemistry learning process in schools still focuses on memorizing concepts, formulas, and terms, which results in limited conceptual understanding and difficulty in connecting the material to everyday life.
2) Thermochemistry is considered a difficult topic because its concepts are abstract and involve complex calculations, which often lead to student misconceptions.
3) Many students experience difficulties in learning thermochemistry, especially in calculating compound heat and enthalpy changes, which indicates both conceptual and technical obstacles in the learning process.
4) The development of digital technology in the Industrial Revolution 4.0 era requires the use of modern learning media, but most materials used in schools remain conventional, less interactive, and not yet adapted to the learning characteristics of Generation Z.
5) Higher Order Thinking Skills (HOTS), which include the ability to analyze, evaluate, and create, have not been fully developed in chemistry learning, even though these skills are essential for 21st-century education.
6) The implementation of innovative learning models such as discovery learning has not been effectively supported by suitable learning media, which reduces the effectiveness of learning activities

1.3 Scope

Based on the problem identification above, the scope of this research includes the following:

1) Assessing the feasibility of the HOTS based e-module integrated with the discovery learning model in the thermochemistry topic.

2) Analyzing teacher and students' responses to the implementation of the HOTS-based e-module integrated with discovery learning in the thermochemistry topic.

3) Examining the effectiveness of the HOTS based e-module integrated with discovery learning in improving grade XI students' learning outcomes in thermochemistry.

1.4 Problem Limitation

Based on the problem identification above, the limitations of this research are as follows:

1) The study is limited to the development of a HOTS based e-module integrated with the discovery learning model.

2) The learning material is restricted to the thermochemistry topic for grade XI senior high school (SMA/MA).

3) The e-module trial is conducted on a limited small scale, involving grade XI Mendel 1 students as the research sample.

4) The research instruments include expert validation sheets, teacher and student response questionnaires, and learning outcome tests analyzed using the N-Gain formula to assess the feasibility and effectiveness of the e-module.

5) This study does not include other chemistry topics beyond thermochemistry and does not involve large-scale implementation or long-term effectiveness testing.

1.5 Problem Formulation

Based on the problem identification above, the research questions are as follows:

1) How feasible is the HOTS based e-module integrated with discovery learning in the thermochemistry topic that has been developed?

2) How do teacher and students respond to the use of the HOTS based e-module integrated with discovery learning in the thermochemistry topic?

3) How does the HOTS based e-module integrated with discovery learning improve students' learning outcomes in thermochemistry?

1.6 Research Objectives

Based on the formulation of the problem, the objectives of this study are as follows:

1) To determine the feasibility of the HOTS based e-module integrated with discovery learning for the thermochemistry topic.
2) To determine teacher and students' responses to the use of the HOTS-based e-module integrated with discovery learning in the thermochemistry topic.
3) To determine how the HOTS based e-module integrated with discovery learning improve students' learning outcomes in learning thermochemistry.

1.7 Benefits of Research

The results of this research are expected to provide the following benefits:

1) For students: To facilitate understanding and enhance motivation in learning thermochemistry through an interactive and HOTS oriented e-module.
2) For teachers: To provide an alternative learning resource that supports the implementation of discovery learning and promotes higher-order thinking skills.
3) For researchers: To serve as a reference for future studies in developing innovative learning media based on HOTS and discovery learning.
4) For schools: To contribute to improving the quality of chemistry learning through the integration of technology and active learning strategies.