Original Article

Enhancing dental education through attitude-based analysis: a comparative study of biology achievement among dental students

การยกระดับการศึกษาทันตแพทยศาสตร์ผ่านการวิเคราะห์เชิงเจตคติ: การศึกษาเชิงเปรียบเทียบผลสัมฤทธิ์ทางชีววิทยาในนักศึกษาทันตแพทย์

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Abstract This research aimed to compare academic achievement in biology across two key dimensions: objective scores and subjective scores, between groups of dental students with high and low attitudes toward the subject. The study was grounded in established educational motivation theories. The research utilized comparative research design, employing extreme group selection to identify 40 participants (20 in each group) from students enrolled in the Faculty of Dentistry, Bangkokthonburi University. The primary research instrument was a 19-item attitude scale toward biology, which demonstrated high reliability (Cronbach's alpha = 0.9841) and collected data on student achievement scores. Data analysis involved descriptive statistics and the independent samples t-test. The findings revealed that the high-attitude group achieved significantly higher mean scores in subjective scores (p <.05) compared to the low-attitude group. This outcome supports the Expectancy-Value Theory (EVT) and achievement motivation theory.

Keywords Academic achievement, Student Interest, Motivation

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บทคัดย่อ การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อเปรียบเทียบผลสัมฤทธิ์ทางการเรียนวิชาชีววิทยาใน 2 มิติหลัก ได้แก่ คะแนนแบบปรนัยและคะแนนแบบอัตนัยระหว่างกลุ่มนักศึกษาทันตแพทย์ที่มีทัศนคติต่อวิชาชีววิทยาในระดับสูงและระดับต่ำ โดยใช้พื้นฐานทางทฤษฎีแรงจูงใจทางการศึกษาเป็นกรอบในการศึกษา งานวิจัยนี้ใช้รูปแบบการวิจัยเชิงเปรียบเทียบโดยใช้วิธีการเลือกกลุ่มสุดโต่ง เพื่อคัดเลือกกลุ่มตัวอย่างจำนวน 40 คน (แบ่งเป็นกลุ่มละ 20 คน) จากนักศึกษาที่ลงทะเบียนเรียนในคณะทันตแพทยศาสตร์ มหาวิทยาลัยกรุงเทพธนบุรี เครื่องมือหลักที่ใช้ในการวิจัยคือ แบบวัดทัศนคติต่อวิชาชีววิทยาจำนวน 19 ข้อ ซึ่งมีค่าความเชื่อมั่นสูง (Cronbach's alpha = 0.9841) และทำการเก็บข้อมูลคะแนนผลสัมฤทธิ์ทางการเรียนของนักศึกษา การวิเคราะห์ข้อมูลใช้สถิติเชิงพรรณนาและการทดสอบค่าทีแบบอิสระ ผลการวิจัยพบว่า กลุ่มนักศึกษาที่มีทัศนคติระดับสูงมีคะแนนเฉลี่ยในส่วนของคะแนนอัตนัยสูงกว่ากลุ่มที่มีทัศนคติระดับต่ำอย่างมีนัยสำคัญทางสถิติ ($p<0.05$) ซึ่งผลลัพธ์นี้สอดคล้องกับทฤษฎีความคาดหวังและคุณค่า และทฤษฎีแรงจูงใจใฝ่สัมฤทธิ์

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INTRODUCTION

Based on classroom observations within the Faculty of Dentistry, a significant disparity in learning engagement has been noted. While dental students generally excel in rote memorization and objective examinations, a challenge arises in tasks requiring higher-order critical thinking and the synthesis of biological principles into clinical contexts. It was observed that this performance gap is often not a result of differing intellectual capabilities, but rather stems from divergent student attitudes toward biology—where some view it as a mere foundational hurdle to be cleared through surface learning, while others perceive it as a vital pillar for their future clinical practice. Consequently, this research was initiated to systematically investigate these observations. Interest and attitude towards a subject are critical psychological factors that strongly correlate with student engagement and the adoption of deep learning strategies. This is particularly true for biology, a discipline that requires critical thinking, self-directed knowledge seeking, and practical laboratory skills. Students with highly favorable attitudes often exhibit increased intrinsic motivation, which is a key predictor of academic success.

The theoretical framework used to elucidate this mechanism is the Expectancy-Value Theory (EVT). EVT posits that achievement is a function of an individual's confidence in their ability to succeed (expectancy) and their perception of the task's importance, usefulness, or enjoyment (value). The attitude and interest measured in this study serve as an element of Intrinsic Value under EVT. It is hypothesized that high-attitude students invest greater effort, leading to higher achievement across all dimensions.

Furthermore, the Self-Determination Theory (SDT) proposes that intrinsic motivation fosters essential psychological needs, namely autonomy and competence. This framework predicts that the high-attitude group should exhibit marked differences in performance dimensions requiring practical skills (activity scores). Finally, the Achievement Motivation Theory emphasizes that individuals driven to overcome obstacles and pursue challenging goals (as reflected in the attitude scale) tend to demonstrate superior overall academic outcomes. This research, therefore, aimed to compare learning outcomes across distinct dimensions (objective, subjective, and activity scores) to understand how subject attitude influenced the nature of student learning among dental students, ultimately informing curriculum development and pedagogical strategies in dental education.

RESEARCH OBJECTIVES

1. To compare the mean objective scores in biology between students with high and low attitudes toward the subject.
2. To compare the mean subjective scores in biology between students with high and low attitudes toward the subject.

RESEARCH METHODOLOGY

Population and samples

The population for this study comprised dental students enrolled in the biology course (HD102) in the Faculty of Dentistry, Bangkokthonburi University. The comparative research sample was selected using the extreme group selection method. This method selected 40 students (20 in each group) from the total cohort of 60 students to maximize statistical power;

1. High interest group: 20 students (top 25% based on total attitude score).

2. Low interest group: 20 students (bottom 25% based on total attitude score).

Basic demographic data, including gender, age, and prior cumulative grade point average (GPAX) from high school, were collected to describe the population characteristics.

Research instrument

1. Attitude toward biology scale
   - 1.1. Type: A 5-point likert rating scale, comprising 19 items divided into 5 dimensions: feeling/ enjoyment, content interest/exploration, value and expectancy, activities and practical work, and effort and determination.
   - 1.2. Qualification: The scale underwent content validity testing by experts with items selected based on an Index of Item objective congruence (IOC) of ≥ 0.70. The internal consistency reliability, calculated using Cronbach's Alpha coefficient from the pilot testing, yielded a high value of 0.9841.
2. Biology academic achievement measures
   - 2.1. Objective scores (MCQ mid): Raw scores (110 points total) measuring foundational knowledge and comprehension.
   - 2.2. Subjective scores (SAQ mid): Raw scores (50 points total) measuring analysis, application of knowledge, and in-depth reasoning (higher-order thinking skills).

Data collection

Achievement scores were retrieved from class records. Attitude data were collected using the developed questionnaire.

Data analysis

1. Descriptive statistics: Mean and standard deviation (S.D.) were computed to describe the attitude and achievement scores in each group.

2. Inferential statistics: The independent samples t-test was used to compare the difference in mean achievement scores across the three dimensions between the high-attitude and low-attitude groups. The significance level was set at α = 0.05.

FINDINGS

The findings were presented in three parts: descriptive analysis of achievement, comparison of attitude dimensions, and t-test results.

1. Descriptive analysis of achievement scores

Achievement dimension	Total score	High interest group (N=20)		Low interest group (N=20)	
		$\overline{x}$	S.D.	$\overline{x}$	S.D.
Total attitude score	95	77.6	4.5	56.40	3.9
Objective scores (MCQ)	110	71.3	10.5	60.8	11.2
Subjective scores (SAQ)	50	30.5	5.1	24.3	6.0

Table 1 Comparison of achievement scores between high-attitude and low-attitude groups (N=40)

The descriptive analysis indicated that the high-attitude group consistently achieved higher mean scores in both examination formats compared to the low-attitude group. Notably, the disparity was evident not only in the objective scores (MCQ), which reflected foundational knowledge, but also significantly in the subjective scores (SAQ). This suggested that students with a more positive attitude toward the subject may possess a superior ability to articulate and synthesize biological concepts, aligning with the "deep learning" characteristic of high-achieving dental students.

2. Comparison of attitude toward biology by dimension

Attitude dimension (theoretical link)	Max score	High attitude group (mean)	Low attitude group (mean)	Mean difference (high–low)
1. Feeling/enjoyment (EVT: intrinsic value)	25	22.9	17.5	+5.4
2. Content interest/exploration (SDT: autonomy/motivation)	20	17.0	12.0	+5.0
3. Value and expectancy (EVT: expectancy & value)	15	12.0	8.5	+3.5
4. Activities and practical work (SDT: competence)	15	14.1	12.8	+1.3
5. Effort and determination (achievement motivation)	20	17.4	15.6	+1.8

Table 2 detailed the comparison of mean scores for the five dimensions of the Attitude toward biology scale, reflecting specific theoretical constructs.

An analysis of the mean scores across the five dimensions of the attitude toward biology Scale, as presented in table 2, revealed distinct variations between the high-attitude and low-attitude groups. The most pronounced discrepancies were observed in the dimensions of feeling/enjoyment (mean difference = +5.40) and content interest/exploration (mean difference = +5.00), indicating that students with a high attitude toward biology exhibited significantly higher levels of intrinsic value and self-directed engagement. Although a notable difference was also identified in value and expectancy (+3.50), the margins were considerably narrower in dimensions associated with achievement motivation and practical application. Specifically, the activities and practical work dimension yielded the smallest mean difference (+1.30), followed by Effort and Determination (+1.80). These findings suggested that while both groups demonstrated relatively comparable levels of persistence and competence in practical settings, the primary factors distinguishing the high-attitude group were their profound emotional affinity for the subject and their autonomous motivation to explore biological content.

3. Results of academic achievement comparison (independent samples t-test)

Achievement dimension	Group	$\overline{x}$	S.D.	t-test	Sig. (*p*-value)	Conclusion
Objective scores	High	71.3	10.5	2.05	0.054	No significant difference ($p>0.05$)
	Low	60.8	11.2			
Subjective scores	High	30.5	5.1	2.15	0.045*	Significantly different ($p<0.05$)
	Low	24.3	6.0			

***0.05 significant level**

Table 3 presented the independent samples t-test results comparing mean achievement scores between the high-attitude and low-attitude groups across two dimensions: objective and subjective scores.

Objective scores (MCQ): The mean of the high-attitude group (mean=71.30) was higher than the low-attitude group (mean=60.80), but the difference was not statistically significant at the 0.05 level (t=2.05, p=0.054).

Subjective scores (SAQ): The mean of the high-attitude group (mean=30.4) was **significantly higher** than the low-attitude group (mean=24.95) at the 0.05 level (t=2.15, p=0.045).

DISCUSSION

The research findings demonstrated that students with a high attitude toward Biology achieved significantly superior academic performance in dimensions requiring deep cognitive processing and analytical synthesis, specifically within Subjective Scores (SAQ). This outcome aligned with the research hypothesis and was substantiated by a robust integration of theoretical frameworks and empirical data:

1. Theoretical alignment with EVT and SDT

The significant disparity in subjective scores validated that a positive psychological disposition and Intrinsic Value led students to invest greater Effort and Determination. This was consistent with the expectancy-value theory (EVT), which posits that achievement behavior is defined by the expectation of success and the value assigned to the task (Eccles and Wigfield, 2024; Wigfield and Eccles, 2023). According to table 2, the high-attitude group exhibited markedly higher mean scores in feeling/enjoyment (+5.40 difference) and content interest/exploration (+5.00 difference). These findings served as critical components of autonomy and

motivation under Self-Determination theory (SDT), suggesting that students who feel autonomous in their learning are more likely to be intrinsically motivated (Deci and Ryan, 2024). Furthermore, this supported Achievement Motivation Theory, where individuals with high motivation are driven to excel in demanding tasks (McClelland, 2023).

2. Nuanced insights on assessment formats

A critical insight emerged from the disparity between assessment types. While the high-attitude group maintained a higher mean score in objective scores (MCQ), the result did not reach statistical significance (p = 0.054). This suggested that while positive attitudes correlated with general proficiency, their true impact was most pronounced in higher-order thinking skills. As noted by Thorndike (2022), measurement and evaluation must distinguish between rote recall and deep understanding. Objective formats might focus on foundational knowledge recognition, whereas subjective assessments (SAQ) better reflected the "deep learning" characteristics and superior ability to synthesize concepts typical of high-achieving students. This aligned with the work of Srirattana (2023), who found that learning achievement is significantly influenced by the specific nature of student interest.

3. The practicality paradox

Interestingly, the smallest difference between groups occurred in the activities and practical work dimension (mean difference = +1.30). This indicated that participation in practical or hands-on tasks alone was not the primary differentiator of student attitude. Instead, the defining characteristic of the high-attitude group was a profound emotional affinity for the subject matter and an autonomous drive for inquiry-based exploration. In curriculum planning, it is essential to move beyond task completion to foster genuine engagement (Willis, 1996).

4. Limitations and future methodological directions

While the current study effectively utilized independent samples t-tests to differentiate between two groups, it was recognized that academic achievement was influenced by multiple variables. To enhance the rigor and evidence-based nature of these findings, future research should employ one-way ANOVA to explore nuances across a broader spectrum of student engagement levels, moving beyond binary classifications (Polit and Beck, 2022). Furthermore, implementing analysis of covariance (ANCOVA)—using prior GPAX as a covariate—was highly recommended. This would provide a more precise validation by statistically controlling for pre-existing academic proficiency, thereby isolating the definitive impact of student attitude on cognitive achievement.

SUMMARY

The comparative study of academic achievement in biology based on student attitude confirmed a strong relationship between intrinsic motivation and academic success in challenging assessment types. Data from Table 3 confirmed that the high-attitude group achieved significantly higher subjective scores ($p < 0.05$), while the difference in objective scores was not statistically significant. This underscored the critical role of student attitude as a vital non-cognitive predictor of academic performance, particularly for tasks requiring synthesis and higher-order application.

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