

# Student-Designed Synthesis of Diarylamines as an Active Learning Strategy in Organic Chemistry

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## INTRODUCTION & AIM

### Background

Advanced Organic Chemistry courses often rely on the study of established synthetic transformations to teach chemical reactivity. Although this approach provides a strong theoretical foundation, it may offer limited opportunities for students to develop research-oriented competencies such as literature consultation, synthetic planning, and experimental decision-making.

Research-based learning strategies can help bridge the gap between theoretical knowledge and authentic scientific practice by engaging students in problem-solving and independent project development.

### Aim

To evaluate the educational impact of a student-designed synthesis activity in which undergraduate students planned and implemented the synthesis of diarylamines based on literature research and synthetic reasoning.

## METHOD

### Participants

- 4 undergraduate Chemistry students
- Activity developed within the framework of the Bachelor's Degree Final Project

### Learning Activity

1. **Methodology Introduction:** Students were introduced to a synthetic methodology for diarylamine preparation. Each student independently was then required to:
2. **Target Selection:** Conduct a literature search and select a diarylamine of interest based on its industrial relevance, properties, or literature presence.
3. **Synthetic Desing:** Each student design a feasible synthetic route justified by bibliographic research (defending starting materials, reaction conditions, and feasibility).
4. **Laboratory Execution:** Carry out the proposed synthesis in the laboratory.

### Assessment

Students received continuous supervision through periodic, structured teacher tutorials.

Learning outcomes were evaluated using:

#### Assessment tool

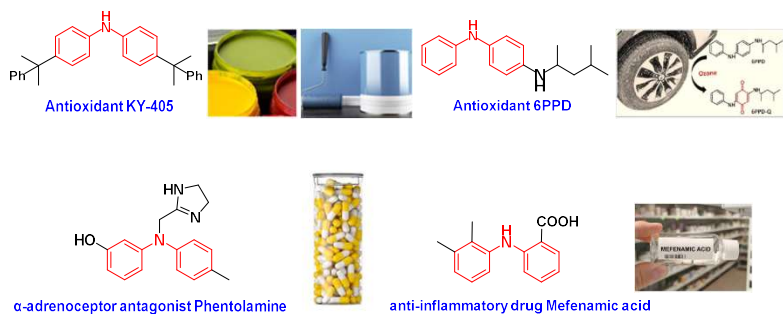
Rubric  
Rubric  
Rubric  
Survey

#### Evaluated competence

Literature search  
Synthetic reasoning  
Experimental execution  
Student perception and confidence

## RESULTS & DISCUSSION

### 1. Selected Arylamines



### Educational Impact

The activity promoted active participation and encouraged students to assume responsibility for their own learning process.

By moving beyond the reproduction of established procedures, students engaged in authentic scientific decision-making, including target selection, route design, and experimental planning.

This approach strengthened the connection between classroom knowledge and real research practice in Organic Chemistry.

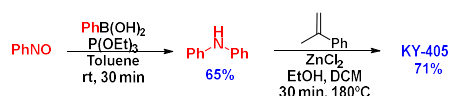
## RESULTS & DISCUSSION

### 2. Synthetic Desing and Laboratory Execution

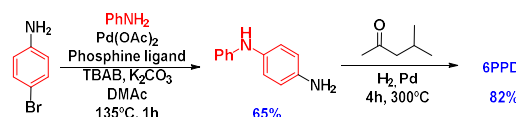
#### Student Performance

Students successfully developed viable synthetic proposals based on bibliographic research and synthetic planning. Students successfully implemented their proposed synthetic routes under laboratory conditions, isolating the target arylamines.

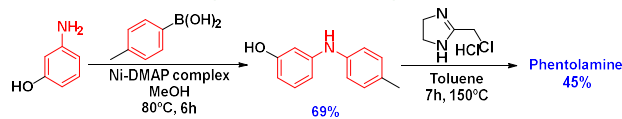
#### Main reaction: Coupling of Nitroarenes and Boronic Acids



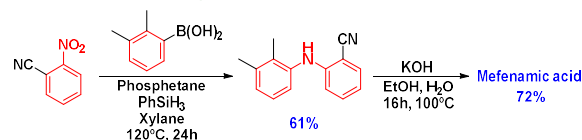
#### Main reaction: Buchwald–Hartwig amination



#### Main reaction: Coupling Chan-Lam coupling reaction



#### Main reaction: Coupling of Nitroarenes and Boronic Acids



### 3. Students perception



## CONCLUSIONS

- Students successfully designed and justified synthetic routes based on literature research.
- The activity fostered autonomy, critical thinking, and synthetic reasoning.
- Research-based learning enhanced the integration of theoretical and practical knowledge.
- The methodology represents a promising active-learning strategy for advanced Organic Chemistry courses.

## FUTURE WORK / REFERENCES

### Future Work

- Scaling up this methodology to larger student cohorts.
- Extend the approach to other synthetic methodologies in Organic Chemistry.

### References

1. Freeman, S. et al. Active Learning Increases Student Performance in Science, Engineering, and Mathematics. *PNAS* **2014**, *111*, 8410.
2. Roscales, S.; Csáký, A. G. Synthesis of Flufenamic Acid: An Organic Chemistry Lab Sequence using Boronic Acids and Nitroarenes under Transition-Metal-Free Conditions *J. Chem. Educ.* **2019**, *96*, 1738.