

# INDUSTRY-LINKED PROJECT WORK: INTERDISCIPLINARITY WITH DESIGN, ENGINEERING AND MANAGEMENT STUDENTS

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## ABSTRACT

Interdisciplinary education has become a universal trend and a staple feature on most university's curricula. Its propensity for interaction among disciplines, purportedly endows students with the skills to tackle complex societal issues that haunt our modern society. A mixed-method study was undertaken to describe the challenges faced by both teachers and students in a second-year bachelor module at the University of Twente. The 15 European credits module funnels three separate tracks: Industrial Design Engineering, Mechanical Engineering and Industrial Engineering Management into an authentic industrial project. Its aim is to foster substantial input from all three specialities in order to solve the proposed problem, and to meet the set learning objectives.

Three issues for students were investigated, (1) communication issues, (2) teamwork problems and (3) prejudices held against the other disciplines. Half of the groups experienced communication issues magnified by the interdisciplinary situation, teamwork issues were present, but were mostly generic and therefore could not be pinned to the interdisciplinary situation alone. Finally, prejudice against disciplines and the feeling of being judged for belonging to a certain discipline was high. Interestingly, the students did not feel that the prejudices inhibited the ability for the team to work together. Teacher challenges included high student numbers and the ripple effects thereof, i.e. time constraints, finding suitable learning spaces, sufficient tutors, etc. These contextual pressures appear to be in direct contrast to the espoused policies of the university. Recommendations on how to mediate some of the issues, such as vigilant alignment of policies to practise and reduction of interdisciplinary knowledge gaps are offered.

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## 1 INTRODUCTION

Interdisciplinary (ID) education aims to develop essential 21st century knowledge, skills and attitudes (KSA) that students can apply later, in their future professional lives (Repko, Szostak, & Buchberger, 2017). Usually, these KSA's are fostered through collaborative project-based learning (PjBL) situations, thus exposing students to authentic interactions with a variety of parties and contexts. The challenges can originate from design obstacles inherent within the module, or from interpersonal complications that accompany most groupwork.

Three challenges, that could arise within an interdisciplinary project context, were used as focus for this study. They were generated through a collation of conclusions drawn from Adams (2007), Repko & Szostak (2017), and Borrego et al. (2013). The possible challenges include: communication problems, the presence of prejudice, and teamwork issues. These issues may have the potential to hinder effective learning and goal attainment. Design obstacles of the module could include suitability of the combination of student tracks or a weak integrated approach from the educators or students (Jacob, 2014).

## 2 METHODOLOGY

### 2.1 Case study setting

The research is a single case descriptive study. It explores the outcomes of the student experience of the interdisciplinary module 'Product Design Consumer Products'. Each year a different company is invited to define a design challenge. It is a mixed-method approach, with a qualitative and quantitative component. Specifically; student surveys, academic staff interviews and document analysis.

### 2.2 Case study details, instruments and sources

*Participants:* The module is fed by three separate tracks (360 students in total, ratio male/female is 3:1). Twelve academic staff were interviewed personally (semi-structured).

*Instrumentation:* A digital survey was sent to all students electronically and was estimated to take approximately 7 minutes. A total of 70 students responded (ratio m/f is 45/25). The survey consists 12 closed questions (Likert scales), and six open questions to gather detailed insights into the students' personal experiences. The closed section of the survey, to gauge value perceptions of ID, bias and communication levels within teams, was based upon parts of the Interprofessional Attitudes Scale (IPAS) (Norris, et.al 2015) and the Interdisciplinary Project Management Questionnaire (IPMQ) (Tormey & Laperrouza, 2019).

*Data Analysis:* Data from both surveys and interviews were processed and themed. Document analysis was undertaken from sources such as governmental publications and the University of Twente's own educational policy documentation.

### 3 RESULTS

**Student Challenges.** ( $n=70$ ) *Personal prejudices*: approximately 80% of students admit to feeling (59) and projecting (54) prejudice from or against other disciplines. Interestingly though, 89% (61) were neutral or denied that the prejudices negatively impacted their ability to work together optimally. Of the communication issues that were present, 80% are related to ID (see *Table 1*). Teamwork is less so, with only 23% identifying a truly ID issue (see *Table 2*).

*Table 1. Communication anecdotes reported by 33 students, those marked with asterisks are ID.*

Categories of answers	Number	Percentage
Discipline-specific homonyms confusing*	12	37%
Perspective taking difficulties*	8	24%
Knowledge gaps*	6	18%
Quality of work (expectations)	5	15%
“Yes” but no further explanation	2	6%

Examples of comments about ID communication issues from the students:

*Mechanical engineering student: “Yes, there was a discussion about the colour foam to be used for a model. I participated in this discussion, only to find out later that the colour of foam specifies hardness and is not about appearance.”*

*Industrial engineering student: “Yes, when a concept or mechanism needed to be explained, there were sometimes misunderstanding because not everybody has the same vocabulary as the IDE people for example.”*

*Table 2. Teamwork and other collaboration related anecdotes reported by 40 students.*

Categories of answers	Number	Percentage
Scheduling and meeting issues (Design issue)	11	28%
Knowledge gaps hindering progress (ID Teamwork issue)	9	23%
Complaints about Management students’ lack of role (Design issue)	8	20%
Differences in tackling the project (Teamwork issue)	7	18%
Unequal distribution of work (Design & Teamwork issue)	5	13%

Examples of comments about ID teamwork issues from the students:

*Industrial design engineering student: “Some people are not willing to change their approach to designing a product, because they think their way is the best and most efficient.”*

*Industrial engineering management student: “Yes, sometimes it was hard to understand all the topics, because you do not have previous knowledge. IEM students almost have no knowledge about any of the topics, so that sometimes was a problem.”*

**Module Challenges.** Academic staff issues are concerned with high student numbers and it was found that the problem is in direct contrast to espoused values of the university, i.e. small-scale education. Furthermore, there is a challenge in equally

allocating roles to all three tracks within the project. This was flagged by both teachers and students, and is complicated further due to the module's origins.

#### 4 CONCLUSIONS & DISCUSSION

**Student Challenges. Prejudice.** MacMynowski (2007) posits that prejudice within a team, can have a negative impact on collaboration. The majority of students projected and felt prejudice, however, it did not affect their ability to get on with the task at hand. The motivational perspective on cooperative learning may explain this outcome. According to Slavin (1995), cooperative incentive structures, here the group project, means that the only way students can reach their own goals is through the group being successful. So, this "need to reach their goals", may explain how they can get on with the project-work, despite having feelings of prejudice towards one another. However, we should be cognisant of the fact that there is no way to measure the quality of the project, if prejudice had not been present.

**Communication.** Of the communication issues that were mentioned by just under half of the students, a high proportion were ID in nature. The motivation of the student to expend effort on appreciating the other disciplines' vocabulary, methods, perspectives, etc. is personal. Ariani (2013) posits that dispositional factors such as personality, can play a role in motivation and performance. Thus, certain students may need to be motivated and supported to take a more active role in their own student-led ID education; investing time and energy in seeking elementary information on their fellow discipline's KSAs. Formally instructing students on how to think from different perspectives, providing good examples of standards of work with accompanying rubrics to quantify expected levels, as well as training on introspection and reflection should help to alleviate some of the issues listed in *Table 1*.

**Teamwork.** Of all the collaboration problems mentioned by students, only 23% were solely ID related (knowledge gaps). The rest of the complaints were either design based or generic teamwork issues. This may indicate that the ID dynamic does not have a large effect on basic teamwork when comparing mono-disciplinary and interdisciplinary groups. An opportunity to pre-emptively focus on knowledge gaps between disciplines, at the early stages of the team formation, presents itself. For example, creating an online resource where the fundamentals of the contributing tracks are outlined, and actively encouraging the development of life-long learning skills in students through the promotion of ownership. This could mediate some of the negative consequences of ID ignorance within a group. Taking steps to combine disciplines is primarily a social process, where individuals must communicate and interact often within disparate environments, ideas and bodies of knowledge (Holley, 2009). The unavoidable factor here are the individuals that make up a team. Personality may explain why some teams work well together and others not, therefore this may indicate that ID differences may show less of an effect on the project outcomes than the personality differences within a team.

**Module Challenges.** Rising student numbers is placing added pressure on the time of staff and resources of the university. This rise in numbers is due to the national stimulation of engineering education and expansion of the university through internationalisation. It is in direct contrast to the university's espoused values of "small scale education." Formal and documented alignment of administrative

expectations with the realities of academic staff is imperative to continue quality education and the safety of personnel. Furthermore, the design issues with regard to epistemological sovereignty of one of the tracks (Healy, 2003) is proving to be a recurring theme when feedback is received from students. One of the tracks continues to struggle to contribute meaningfully to the project. Iterations are implemented annually to attempt to mitigate this, however selecting a more suitable project (for all three tracks) seems the most direct path to resolution of this imbalance. Creating a check list of criteria applicable for all three tracks within a project, will in the very least, eliminate unsuitable project initiations.

## REFERENCES

- [1] Adams, W. M. (2007), Thinking like a human: social science and the two cultures problem. *Oryx*, 41(3), 275-276. Doi:10.1017/S0030605307004131
- [2] Borrego, M., Karlin, J., McNair, L. D., & Beddoes, K. (2013), Team Effectiveness Theory from Industrial and Organizational Psychology Applied to Engineering Student Project Teams: A Research Review. *Journal of Engineering Education*, 102(4), 472-512. Doi:10.1002/jee.20023
- [3] Healy, S. (2003). Epistemological pluralism and the 'politics of choice'. *Futures*, 35(7), 689-701. [https://doi.org/10.1016/S0016-3287\(03\)00022-3](https://doi.org/10.1016/S0016-3287(03)00022-3).
- [4] Holley, K. A. (2009). Special Issue: Understanding Interdisciplinary Challenges and Opportunities in Higher Education. *ASHE Higher Education Report*, 35 (2): 1–131.
- [5] Jacobs, J. A. (2014), In defence of disciplines: Interdisciplinarity and specialization in the research university. University of Chicago Press.
- [6] Norris, J., Lassche, M., Joan, C., Eaton, J., Guo, J., Pett, M., & Blumenthal, D. (2015). The Development and Validation of the Interprofessional Attitudes Scale: Assessing the Interprofessional Attitudes of Students in the Health Professions. *Academic Medicine*. 2015 Oct; 90:1394-1400. PMID 25993280. [Http://www.ncbi.nlm.nih.gov/pubmed/25993280](http://www.ncbi.nlm.nih.gov/pubmed/25993280).
- [7] Repko, A. F., Szostak, R., & Buchberger, M. P. (2017), Introduction to interdisciplinary studies.
- [8] Tormey, R., & Laperrouza, M. (2019) Interdisciplinary Project Management Questionnaire (IPMQ).