

INTERDISCIPLINARY TEAM TEACHING FOR ENGINEERING SPECIALITIES

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Abstract

In recent years, team-taught courses have become an important part of the higher educational systems worldwide. Team teaching has found a place in many different departments, programmes, and disciplines, at levels ranging from undergraduate lectures to graduate courses. Team teaching boasts many pedagogical and intellectual advantages: it can help create a dynamic and interactive learning environment, provide instructors with a useful way of modelling thinking within or across disciplines, and also inspire new research ideas and intellectual partnerships among lecturers. This paper presents an example of a pilot interdisciplinary team teaching training at the University of Forestry held with Master degree students from the speciality Wood Technology, Faculty of Forest Industry. The results of this training suggest that the affective and cognitive transformations experienced in team-taught courses are important for stimulating students' creative and critical thinking. However, to experience all benefits of interdisciplinary team teaching, lecturers must adjust their course planning and classroom management strategies in order to accommodate a collaborative approach.

Key words: interdisciplinary team teaching, foreign language training, engineering specialities.

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Introduction

Educational experiences are more authentic and of greater value to students when the curricula reflects real life, which is multi-faceted rather than being compartmentalized into neat subject-matter packages. Real-world problems are complex, so no single discipline can adequately describe and resolve these issues.

Interdisciplinary instruction entails the use and integration of methods and analytical frameworks from more than one academic discipline to examine a theme, issue, question or topic. Interdisciplinary education makes use of disciplinary approaches to examine topics, but pushes beyond by: taking insights from a variety of relevant disciplines, synthesizing their contribution to understanding, and then integrating these ideas into a more complete, and hopefully coherent, framework of analysis.

In dealing with multi-faceted issues interdisciplinary perspectives are needed to adequately address the complexity of the problems and to forge viable policy responses.

Interdisciplinary teaching is different from multi- or cross-disciplinary teaching in that it requires the integration and synthesis of different perspectives rather than a simple consideration of multiple viewpoints.

What Makes Interdisciplinary Teaching Different?

A single disciplinary perspective often has limitations in that it is driven by the norms and framework of a particular discipline without consideration and incorporation of alternative views. The single disciplinary view can lead to hegemony which prevents critical assessment of both their own and other perspectives. In contrast, interdisciplinary education draws on multiple disciplines to acquire a deep and

thorough understanding of complex issues and challenges students to synthesize what each of the disciplines offers before attempting to design efforts to resolve noted concerns.

Engaging students and helping them to develop knowledge, insights, problem solving skills, self-confidence, self-efficacy, and a passion for learning are common goals that educators bring to the classroom and interdisciplinary instruction and exploration promotes realization of these objectives. Interdisciplinary teaching fosters advances in cognitive ability. The main distinct educational benefits of interdisciplinary learning include the ability to recognize bias; think critically; tolerate ambiguity; acknowledge and appreciate ethical concerns. Interdisciplinary teaching helps to uncover preconceptions by introducing students to subject matter from a variety of perspectives that challenge their existing notions. It also fits with recent advances in learning science about how to foster learning when students bring powerful pre-existing ideas with them to the learning process. According to some authors the interdisciplinary forms of instruction help students overcome a tendency to maintain preconceived notions. Interdisciplinary teaching accomplishes this goal in two ways. Firstly, by helping students identify insights from a range of disciplines that contribute to an understanding of the issue under consideration. Secondly, by helping students develop the ability to integrate concepts and ideas from these disciplines into a broader conceptual framework of analysis.

When students put aside their pre-existing notions they position themselves to learn facts more readily and are more open to adopting a range of methodologies that promote understanding. Trainers can thus spend more time exploring issues with them that promote significant learning.

Significant Learning takes place when meaningful and lasting classroom experiences occur. According to some authors when trainers impart students with a range of skills, and insights about the

educational process that students will see as meaningful and salient to them they promote student engagement in the learning process and greater learning occurs. There are 6 key elements of the educational process that lead to significant learning and each of these is a common feature of interdisciplinary forms of instruction:

- Foundational Knowledge – acquiring information and understanding ideas;
- Application – acquiring an understanding of how and when to use skills;
- Integration – the capacity to connect ideas;
- Human Dimension - recognition of the social and personal implications of issues;
- Caring – acknowledgment of the role of feelings, interests, and values;
- Learning How-to-Learn – obtaining insights into the process of learning.

Interdisciplinary instruction fosters the acquisition of foundational knowledge, promotes integration of ideas from multiple disciplines and provides insight on how to apply knowledge all of which advance students' understanding of how to learn. Moreover, students are encouraged to account for the contribution of disciplines that highlight the roles of caring and social interaction when analysing problems. Thus, the very structure of interdisciplinary learning is consistent with the core features of significant learning, so students are expected to find interdisciplinary education engaging and thus an effective way to advance their understanding of topics under investigation.

Interdisciplinary teaching helps students develop their cognitive abilities - brain-based skills and mental processes that are needed to carry out tasks. Interdisciplinary learning fosters a number of cognitive attributes. It helps students to:

- Acquire perspective-taking techniques - the capacity to understand multiple viewpoints on a given topic. Students develop an appreciation of the differences between disciplines on how to approach a problem and their discipline specific rules regarding viable evidence. This leads to a broader understanding of the issue under investigation;
- Develop structural knowledge - both declarative knowledge (factual information) and procedural knowledge (process-based information). Each of these forms of knowledge are needed to solve complex problems. Thus, as students enhance their knowledge formation capacity, trainers can engage them in conversations dealing with more complex issues;
- Integrate conflicting insights from alternative disciplines. Each discipline adopts different mechanisms of analysis and approaches to evaluate the viability of their insights. Obtaining a clear understanding of problems with roots in multiple disciplines requires the capacity to integrate ideas and

this skill is advanced by interdisciplinary learning.

Interdisciplinary instruction helps students understand why conflicts commonly arise over; the causes and consequences of an issue and, the ideal way for policy to address the issue of concern. When learning is confined to a single disciplinary perspective ambiguity is often considered either a shortcoming of the analytical framework or evidence that assumptions need to be adopted to provide a clear prediction. Interdisciplinary teaching advances the notion that ambiguity results from alternative perspectives on issues that are advanced by different disciplines rather than a shortcoming of a particular discipline. Thus, students acquire a better understanding of the complexity of problems of interest and the associated challenges of solving them.

Interdisciplinary teaching promotes understanding when students learn in heterogeneous ways. Students bring multiple forms of intelligence to the learning process due to their diverse backgrounds, interests, experiences, talents, and values. Interdisciplinary teaching opens academic conversations to ideas from a range of disciplines so all students should be able to relate and contribute to the dialogue. Thus, the likelihood of connecting with the full array of the students in the classroom is enhanced by interdisciplinary learning.

Moving from a disciplinary oriented form of teaching to being an interdisciplinary educator is not too costly for four reasons. First, most educators are familiar with the methodologies and empirical practices of related disciplines so acquiring the necessary cross disciplinary knowledge to become an interdisciplinary trainer will not be overly stressful or time consuming. Second, most educators are familiar with task modeling – an instructional strategy that promotes learning through observation - which is fundamental to interdisciplinary teaching since most students are unfamiliar with interdisciplinary approaches to learning, so instructors do not have to learn an entirely new form of pedagogy. Third, synthesis of insights from across disciplines, the most demanding element of interdisciplinary teaching, is an activity that most scholar-educators have engaged in previously or can learn to do with modest effort. Finally, instructors can determine the share of the course that is interdisciplinary, so they insert into their course the level of interdisciplinarity that is ideal for them given their experience with this form of teaching and the nature of the course they are leading.

Interdisciplinary Team Teaching

Team teaching involves a group of instructors working purposefully, regularly, and cooperatively to help a group of students of any age learn. Trainers together set goals for a course, design a syllabus, prepare individual lesson plans, teach students, and evaluate the results. They share insights, argue with one another, and perhaps even challenge students

to decide which approach is better. There are three main types of team teaching: (1) two or more trainers loosely sharing responsibilities; (2) team planning, but individual instruction; and (3) joint planning, instruction, and evaluation of learning experiences. Innovations are encouraged, and modifications in class size, location, and time are permitted. Different personalities, voices, values, and approaches spark interest, keep attention, and prevent boredom.

The team-teaching approach allows for more interaction between trainers and students. Trainers evaluate students on their achievement of the learning goals; students evaluate trainers on their teaching proficiency. Emphasis is on student and trainer development, balancing initiative and shared responsibility, specialization and broadening horizons, the clear and interesting presentation of content and student development, democratic participation and common expectations, and cognitive, affective, and behavioral outcomes. This combination of analysis, synthesis, critical thinking, and practical applications can be done at all levels of education.

Working as a team, trainers model respect for differences, interdependence, and conflict-resolution skills. Team members together set the course goals and content, select common materials such as texts and films, and develop tests and final examinations for all students. They set the sequence of topics and supplemental materials. They also give their own interpretations of the materials and use their own teaching styles. The greater the agreement on common objectives and interests, the more likely that teaching will be interdependent and coordinated.

Teaching periods can be scheduled side by side or consecutively. For example, trainers of two similar classes may team up during the same or adjacent periods so that each trainer may focus on that phase of the course that he or she can best handle. Students can sometimes meet all together, sometimes in small groups supervised by individual trainers or teaching assistants, or they can work singly or together on projects in the library, laboratory, or fieldwork. Trainers can be at different sites, linked by video-conferencing, satellites, or the Internet.

Breaking out of the taken-for-granted single-subject, single-course, single-trainer pattern encourages other innovations and experiments. For example, students can be split along or across lines of sex, age, culture, or other interests, then recombined to stimulate reflection.

Benefits and Challenges of Interdisciplinary Team Teaching

Team teaching boasts many pedagogical and intellectual advantages: it can help create a dynamic and interactive learning environment, provide instructors with a useful way of modeling thinking within or across disciplines, and also inspire new research ideas and intellectual partnerships among trainers. To experience the full benefits of team teaching, however, instructors must adjust their

course planning and classroom management strategies to accommodate a collaborative approach.

Team teaching requires different preparation than traditional, single-instructor courses, particularly concerning the organizational aspects of course management. Careful and extensive planning can help instructors prevent disagreements regarding assignments, grading procedures, and teaching strategies. Planning meetings also allow instructors to familiarize themselves with their partner's material, helping make the class a true team effort from the start. Reaching this consensus may take a lot of time and compromise, in the end the extra effort will result in a far more successful intellectual experience.

The purpose of a team-taught course, from an educational standpoint, is to push students to achieve higher levels of synthesis and integration in their study of new material. It is, therefore, vitally important for instructors to model the process of integration by interweaving teaching partners' perspectives into each presentation. Often students are assigned projects that require them to integrate the material individual instructors have presented. Consequently, students have expressed a desire for trainers to demonstrate the same practice of integration in their own lectures and presentations. Trainers often integrate their different disciplinary approaches by referring to each other in lectures and presentations. By showing respect for each other's ideas, even when they may disagree, they are able to keep students interested and engaged in all aspects of the course material.

Some teaching teams take a more direct approach, and assign one instructor during each class meeting the task of making connections among different course topics. Whichever method instructors choose, giving students the opportunity to observe integration in action helps them better understand instructors' expectations, as well as improve their own learning outcomes.

Team-teaching allows students to observe high-level intellectual debate among colleagues. When such debates are successful, students learn to disagree without hostility. They also learn how to encounter new material through a variety of perspectives, and gain a practical knowledge of different academic disciplines. Watching instructors debate using different methodological approaches allows students to discover the advantages of different disciplines, and to understand which methodology best suits a particular line of inquiry. In addition, interdisciplinary debate encourages students to apply the skills of integration and collaboration to other courses and assignments.

One of the benefits that team teaching offers students is an increase in the amount of feedback they receive from instructors. Students often worry whether instructors will apply consistent grading standards. Conflicts can emerge regarding the standards for evaluating student work, and instructors sometimes struggle to bridge their differences

regarding evaluation procedures or criteria. To ensure fairness in grading, some instructors design a specific grading rubric, tailored to the needs of a team-taught course.

In addition to increased preparation time, successful team teaching also requires ongoing meetings among instructors to review and reassess their goals for the course. For many team trainers, meetings become the testing ground for the sort of dialogic instruction they present in class. Meetings allow instructors time to plan upcoming courses, but also to reflect upon their progress thus far, and to compare their impressions regarding student response and engagement.

Students in team-taught courses learn new material by approaching it from many different perspectives. The dialogic structure of class meetings often stands in stark contrast to the lecture format to which many students and instructors are accustomed. Instructors must, therefore, adjust their teaching practices to invite many different responses to a particular question or issue.

Although many students enjoy the diversity of voices and viewpoints that emerge in the team-taught classroom, others struggle to figure out the key points of a lesson when trainers choose to present many possible solutions to a problem.

Team teaching can have a highly positive impact on student learning outcomes, largely due to the increased opportunity for student participation that team teaching provides. The presence of more than one instructor in the classroom increases the occasions for student-trainer interaction. More importantly, a collaborative teaching environment invites students to take a more active role in the learning process. Because team teaching encourages a variety of perspectives on a topic, students are more likely to feel they can make valuable contributions to class discussions.

Part of the challenge of team teaching is putting yourself in a position where your own authority and expertise on a certain topic may have to take a backseat. Trainers must make the shift from being “experts” to being “expert learners,” for in the collaborative classroom, trainers and students join in a shared process of intellectual discovery. Instructors generally agree that being prompted to look at a topic from a different angle can be one of the most rewarding experiences of participating in a teaching team. Trainers can “get out of their own conceptual boxes” and learn new approaches that will enhance their own research and writing. In addition to creating new research opportunities, team teaching can also encourage instructors to hone their pedagogical skills.

Team teaching gives trainers the opportunity “to teach in a different way, and to learn in a different way.” It allows instructors to hone their pedagogical skills and develop new topics for research and scholarship. The benefits of team teaching extend to students as well, improving learning outcomes by offering increased student-trainer interaction, as well as

a multi-dimensional approach to subject matter. Ultimately, the advantages of team teaching far outweigh the time and energy it requires.

Design and implementation of interdisciplinary team teaching

Pilot implementation of interdisciplinary team teaching at the University of Forestry involving two lecturers, teaching English for Specific purposes, on the one hand, and Industrial Ecology and Occupational Safety, on the other hand, was carried out with Master degree students from the specialities Wood Technology and Interior and Furniture Design.

It was decided to use the method of team planning followed by individual instruction in the classroom.

The first step in developing the interdisciplinary training was to plan the topics to be examined in an interdisciplinary manner and to clearly define the learning outcomes and results. The key terms related to each topic were carefully selected and determined by the leading specialist in the field of Wood Technology. The content of the theoretical training modules, the relevant case studies and practical exercises were also determined following the curriculum of the speciality.

This pre-instructional planning allows the trainer to acquire the requisite knowledge, and to develop an action plan that may include open-type questions - to guide the classroom experience.

Then the methodology was introduced to students emphasizing on to the nature of interdisciplinary, rather than discipline-based learning. The goal was to impress upon them the importance of integrating insights and approaches from multiple disciplines to form a framework of analysis that will lead to a rich understanding of complex questions.

The following 7 basic steps were used to engage students in the interdisciplinary exploration: DEFINITION of problems, issues, topics or questions that permit interdisciplinary examination; PRESENTATION of a clear rationale for taking interdisciplinary approach including the advantages to be gained; IDENTIFICATION of relevant disciplines; CONDUCTING a literature review (what is known on the topic from each of the disciplines); DEVELOPMENT of a command of each relevant discipline set out the analytical structure central to each discipline, identify key underlying assumptions, and methods of evaluation; CREATION of common ground by developing a cohesive framework of analysis that incorporates insights from the relevant disciplines in a systematic manner; COMBINATION of disciplinary insights to construct new more integrated understanding of the topics.

The following structure of the lessons was adopted: Can Do – Warm Up – Learning Tasks. Each lesson is supplemented by case studies and practical tests for self-assessment.

The Can Do aims at guiding the process of self-regulated learning. These Can Do statements describe the specific language tasks that learners are

likely to perform at various levels of proficiency. The more learners are engaged in their own learning process, the more intrinsically motivated they become.

Each lesson begins with several introductory questions to the subject matters (Warm Up). They are intended to identify the existing level of knowledge on the topic, to initiate discussions and stimulate creative thinking of students. These are open questions, guiding students to recover previous knowledge on the respective topic acquired from the training in the different disciplines, conducted in Bulgarian language.

The core element of the lessons is a text for understanding (reading comprehension text), containing the main terms of the respective topic. The texts are scientific or scientific-popular and present summarized information concerning the topic of the lesson.

The level of comprehension is checked using the developed practical (mainly lexical) exercises, aimed at enhancing learners' theoretical knowledge.

An example of the lessons is given below.

Vibrations

Can Do

CAN read scientific and scientific-popular articles concerning the topic of Vibrations;

CAN use the specific terms in this field;

CAN express own opinion and present arguments;

CAN write a summary of articles, make presentations.

Warm Up

1. *What does the abbreviation HAVS stand for? Have you ever heard of it?*

2. *What can we do to reduce the risk of vibrations in woodworking industry?*

Learning Tasks

Read the text below and write a short summary (no more than 10 lines).

Hand-arm vibration is vibration transmitted from work processes into workers' hands and arms. Regular and frequent exposure to hand-arm vibration can lead to permanent health effects. This is most likely when contact with a vibrating tool or work process is a regular part of a person's job.

Both hand-held and stationary woodworking tools can cause vibration "white fingers" or hand-arm vibration syndrome (HAVS). While it has been known since the beginning of the 20th century that vibration affects the hands and arms, it was not until 1983 that scientists agreed on a definition of HAVS that includes the circulatory, nervous and musculoskeletal systems.

White fingers, or Raynaud's Syndrome, is a disease of the hands in which the blood vessels in the fingers collapse due to repeated exposure to vibra-

tion. The skin and muscle tissue do not get the oxygen they need and eventually die. HAVS is a more advanced condition and the entire hand or arm may be affected by exposure to vibration. HAVS is a chronic and progressive disorder and the time from first exposure to vibration and the blanching of fingertips in the cold (latent interval) can vary from a few months to several years. Early signs of HAVS are infrequent feelings of numbness and/or tingling in the fingers, hands, or arms, or numbness and whiteness in the tip of the finger when exposed to cold. As the disease progresses, a worker experiences more frequent attacks of numbness, tingling, and pain and finds it difficult to use his or her hands. A worker with advanced HAVS may be disabled for a long amount of time.

Vibration isolators or damping techniques on woodworking equipment offer the most effective protection. Determining the correct type and quantity of damping material to use for a particular machine is a complicated process and should be left to a knowledgeable person. However, there are other techniques that can be used to reduce the risk of HAVS. Maintain machines in proper working order. Unbalanced rotating parts or unsharpened cutting tools can give off excessive vibration. Arrange work tasks so that vibrating and non-vibrating tools can be used alternately. Employers should restrict the number of hours a worker uses a vibrating tool during the workday and allow employees to take 10 to 15 minute breaks from the source of the vibration every hour. Workers should be also instructed to keep their hands warm and dry, and not to grip a vibrating tool too tightly. Workers should allow the tool or machine to do the work.

If you suspect that you have symptoms of HAVS then see your doctor. If your doctor confirms HAVS, there are several things you should do to prevent symptoms from getting worse. Stop using vibrating tools if possible. Bouts of Raynaud's phenomenon may ease off if symptoms are mild and you stop working with vibrating tools. However, it is not clear whether nerve symptoms can improve once they have developed. If possible, you should consider a change of job. Other precautions aim to prevent the blood vessels from collapsing. Smoking may make symptoms worse. The chemicals in tobacco can cause the small blood vessels to narrow. Some medicines that are used to treat other conditions sometimes trigger symptoms, or make them worse. Caffeine triggers symptoms in some people. It is also important to keep your hands warm. Warm gloves are essential when you are out in cool weather. Keep your whole body warm, not just your hands. Although your hands are the most important, symptoms are less likely to occur if you keep your entire body warm. So, wrap up warmly before going into cooler areas such as outside on cold days. Exercise your hands frequently to improve the circulation. When a bout or symptoms develop, warm the hands as soon as possible. Soaking the hands in warm running water is a good way to get warm.

Exercise 1. Read the text again and answer the following questions:

- 1) What is HAVS?
- 2) What causes HAVS?
- 3) What are the symptoms of HAVS?
- 4) How long does it take for the symptoms to develop?
- 5) How can you prevent HAVS?
- 6) What can you do if you have HAVS?

Exercise 2. Match the words or phrases with their definitions. Use a good dictionary if necessary.

- | | | |
|------------------|----|---|
| 1) Blood vessels | a) | uncertain feeling similar to having a lot of ants over your hand or foot |
| 2) Disorder | b) | no sensation (e.g. in fingers) and/or inability to move |
| 3) Circulation | c) | an unhealthy condition of a part, organ, or system caused by infection, genetic defect, or environmental causes |
| 4) Tingling | d) | whitening, losing colour |
| 5) Numbness | e) | the act of grasping, holding something fast |
| 6) Blanching | f) | arteries, veins, or capillaries through which the blood circulates |
| 7) Grip | g) | the continuous movement of blood through the heart and blood vessels |
| 8) Symptoms | h) | a very sudden appearance of disease symptoms |
| 9) Damping | i) | a sign or indication of a disease |
| 10) Bouts | j) | vibration-decreasing measures |

Exercise 3. Fill in the gaps with words and phrases from exercise 2.

The hand-arm vibration syndrome is a 1 _____ caused by working with vibrating tools for too long. The main 2 _____ of HAVS include 3 _____ and 4 _____ in fingers, as well as their 5 _____ - this is why HAVS is often called also "white fingers". Experts believe that the aforementioned displays of HAVS, which often come in 6 _____ after touching cold objects, are caused by collapsing 7 _____ in fingers and hands, limiting blood 8 _____. The most basic measures of protection against HAVS is installing 9 _____ equipment and making sure that the 10 _____ on vibrating tools is not too firm. If you discover any HAVS symptoms, see your doctor immediately!

Exercise 4. Read the text carefully and decide if the statements are true (T) or false (F). Correct the false ones.

- 1) HAVS affects fingertips only. T F
- 2) It can take several years for the symptoms to develop. T F
- 3) Only hand-held tools can cause HAVS. T F
- 4) The first symptom of HAVS is severe pain in fingertips. T F
- 5) Firm grip on vibrating tools can prevent HAVS. T F
- 6) Unsharpened tools generate excessive vibration. T F
- 7) Vibration isolators are very effective against HAVS. T F
- 8) Temperature doesn't affect the disease. T F

Exercise 5. Work in pairs. Look at the false sentences in exercise 4. Why are they wrong?

Exercise 6. Write a short paragraph about your workplace or company. Name some of the wood-working tools there that emit vibrations. Comment on how likely it is for you or workers in your company to develop HAVS and what measures are implemented to prevent it. You can also suggest some changes. Write about 100 words.

Conclusions

Interdisciplinary team teaching has certain advantages over other team teaching models; the strengths of lecturers from different departments can be highlighted to help the students.

Based on the carried out pilot training using interdisciplinary team teaching methods, the following important factors are necessary for a successful team teaching course: (1) well matched and like-minded team members, (2) mutual dedication to team teaching and ongoing communication, (3) an interest in relating the content or curriculum to real life, and (4) a strong desire to stimulate the students' learning.

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