Benefits and Challenges of Multi-disciplinary education

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What is multidisciplinary? 2 definitions:

1. Mul.ti·dis·ci·pli·nar·y adj
   Of, relating to, or making use of several disciplines at once
   (Thefreedictionary.com)

2. Multidisciplinarity is a non-integrative mixture of disciplines in that each discipline retains its methodologies and assumptions without change or development from other disciplines within the multidisciplinary relationship.
   (Wikipedia)
Outline

- Multidisciplinarity
- Infrastructure development - need for multidisciplinarity
- Benefits and challenges in multidisciplinary education
- Two examples of multidisciplinary courses - design elements and experiences
- Illustrative example of water management
- Discussion

Characteristics of a multi-disciplinary course

In a multi-disciplinary course, students are exposed to selected key theories, methods and techniques of different scientific disciplines that are jointly applied to a field of study or professional practice.
Why multidisciplinary?

The multidisciplinary approach is considered particularly useful in the field of infrastructure and community development, because such development is by definition multi-disciplinary in nature. Without planning, engineering, sociological, economic and environmental knowledge and understanding, no infrastructure project can be successfully developed, implemented and sustained.

Management of Infrastructure for Community Development - aspects

- Integrated infrastructure systems
- Performance of infrastructure systems
- Impacts of infrastructure systems
- Policy and planning for infrastructure
- Sustainable development (People, planet, profit)
- Community oriented governance in infrastructure development
- Community involvement in infrastructure planning, engineering and maintenance
Interrelations between aspects of integrated infrastructure and community development

- **The Community** (The beneficiary?)
  - Creates diverse and dynamic response

- **The Context**
  - Defines conditions and limitations in infrastructure development

- **The Integrated Infrastructure Development Process**
  - Infrastructure characteristics determine the process and vice versa
  - Policies determine infrastructure options and vice versa

- **The Physical Infrastructure**
  - Plays a key role

- **The Policies**
  - Governs planning levels and quality

Potential benefits

- Students are exposed to theoretical principles from different scientific backgrounds
- Students can qualify themselves in a larger variety of subjects
- Students are expected to develop a more open, critical and reflective attitude, coming from different backgrounds and being exposed to different disciplines and viewpoints.
Triggering scientific interest and creativity

Equations for social forces (Helbing) to describe pedestrian behaviour

- Pull towards desired goal location
  \[ \mathbf{F}_{a}^{0}(\mathbf{v}_{a}, v_{a}^{0}) = \frac{1}{r_{a}}(v_{a}^{0} \mathbf{e}_{a} - \mathbf{v}_{a}) \]

- Push away from obstacles
  \[ \mathbf{F}_{ab}(\mathbf{r}_{ab}) = -\nabla_{\mathbf{r}_{ab}} U_{ab}^{0} e^{-V_{ab}^{0} \mathbf{r}_{ab}} \]

- Push away from people
  \[ \mathbf{F}_{ab}(\mathbf{r}_{ab}) = -\nabla_{\mathbf{r}_{ab}} V_{ab}^{0} e^{-b/\alpha} \]

- Pull towards grouping
  \[ \mathbf{F}_{a}(\|\mathbf{r}_{a}\|; t) = -\nabla_{\mathbf{r}_{a}} W_{at}(\|\mathbf{r}_{a}\|; t) \]
Analyses of analogies are examples of disciplinary exchange of theories and approaches.

Gravity model in transport planning

\[ F_g = G \frac{m_1 m_2}{r^2} \text{ distance: } r \]

\[ T_{ij} = \mu \frac{\text{Pop}_i \text{Pop}_j}{d_{ij}^2} \rightarrow T_{ij} = \mu X_i Q_j f(c_{ij}) \]

Challenges

- Selecting those key theories, concepts and methods that are required for understanding and being able to further contribute to the field of study
- Offering subjects at an accessible entry level, yet achieving sufficient depth.
- Keep the study load at an acceptable level
- Allowing for specialisation
Challenges (2)

- Acceptance of the multidisciplinary course in a mono disciplinary scientific environment (in view of professional certification, scientific accreditation, scientific publication opportunities)
- Creating and convincing job market

Example 1: ITC course on Urban Planning and Management

- 9-month Post-graduate Diploma
- 18-month Master of Science degree
- 3-month short course
Urban Planning and Management (UPM)

Urban Problems
Urban Planning and Management (UPM)

Urban Planning and Management

Urban @ ITC

- Understanding Urban Dynamics
- Planning and Decision making
- Effective use of geo-information
Urban Planning and Management (UPM)

- Urban Poverty and Slum Upgrading
- Urban Transport
- Infrastructure and Public Services
- Hazards, Disaster Preparedness and Mitigation
- Urban Environmental Management
- Land Use and Land Tenure

Objectives of UPM

The aim of the MSc course Urban Planning and Management is that upon completion of the course, you should be able to develop geo-information science-based approaches for effective task execution and problem solving in urban planning and management.

- critical attitude and autonomous learning skills
- geo-information science and urban planning & management for effective task execution and problem solving in urban areas
- contribute through research to the development of geo-information-based knowledge in urban planning and management
- be able to effectively communicate in a multi-stakeholder working environment
Various scientific disciplines

Within the UPM course various scientific disciplines are combined to address the planning and management of dynamic urban regions.

- Human and Physical Geography
- Engineering Sciences
- Geographic Information Science
- Economics
- Environmental sciences
- Other social science disciplines

Students from different backgrounds

- Urban and Regional Planning
- Geography
- (Civil) Engineering,
- Economics
- Environmental Sciences
- Geodesy

In addition, students are from different nationalities. Project based learning contributes to the exchange of disciplinary, methodological and cultural information.
Motivation for going multi-disciplinary

The professional practice of people working in urban planning and management is multi-disciplinary in nature. Being able to analyse and understand urban development and develop effective interventions requires knowledge from several disciplines. Also scientific work in urban planning and management is increasingly multi-disciplinary in nature. Therefore there is a need to educate multidisciplinary students.

Structure UPM course and subjects

<table>
<thead>
<tr>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
<th>Block 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principles of RS and GIS (4 modules)</td>
<td>Scientific domain (6 modules)</td>
<td>Research profile (5 modules)</td>
<td>Individual MSc research (8 modules)</td>
</tr>
</tbody>
</table>

- 3 month short course
- 9-month PGD
- 18 month MSc

Evolving multidisciplinarity of subjects offered

- mono
- multi
- multi and specialisation
- specialisation
### UPM structure: PGD + MSc

<table>
<thead>
<tr>
<th>1</th>
<th>Urban Planning and Management</th>
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<tbody>
<tr>
<td>2-4</td>
<td>Geo-information Science and Earth Observation</td>
</tr>
<tr>
<td>5-7</td>
<td>UPM I- Nature and dynamics of urban regions</td>
</tr>
<tr>
<td>8-10</td>
<td>UPM II- Developing Spatial Interventions</td>
</tr>
<tr>
<td>11</td>
<td>MSc Research methods</td>
</tr>
<tr>
<td>11-12</td>
<td>Final Project</td>
</tr>
<tr>
<td>12-13</td>
<td>MSc advanced subjects</td>
</tr>
<tr>
<td>14-15</td>
<td>MSc research projects</td>
</tr>
<tr>
<td>16-23</td>
<td>MSc thesis research</td>
</tr>
</tbody>
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### Some experiences from students

- Students are generally very satisfied with the course and indicate that they have learnt a lot and have developed useful skills.
- Students indicate that there is a risk of too much fragmentation if too many subjects are offered.
- Students appreciate the involvement of theory and concepts from different disciplines, but stress the need to have sufficient room for specialization towards the end of the programme.
- Students complain about the high study load.
Example 2: University of Twente course on Civil Engineering & Management

- 36 month Bachelor of Science degree
- 24 month Master of Science degree

Disciplines

- Civil Engineering
- Governance studies
- Administrative law/contracting
- Economics
- Environmental studies
- Applied Mathematics
- Management studies
Specialisations in Master phase

- Water Resources Management
- Transport Engineering & Management
- Construction Process Management

Combination/selection of elements: specialisations and aspects

- Water
- Transport
- Construction

<table>
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<tr>
<th>Design</th>
<th>Modelling</th>
<th>Management</th>
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A car model representing the combination of Water and Design.
Course design elements

- “Pushpin” model
- Systems analysis (integrative element)
- Project based learning (stepwise approach)

Example: systems analysis approach

Car and public transport vicious circle
Breaking the car/public transport vicious circle

Stepwise project based learning

- 1<sup>st</sup> year BSc level: monodisciplinary group (teamwork, presentation/reporting)
- 2<sup>nd</sup> year BSc level: “bi”disciplinary project group
- 3<sup>rd</sup> year BSc level: multidisciplinary group project
- BSc project: small scale practical multidisciplinary individual project
- 1<sup>st</sup> year MSc level: small scale scientific multidisciplinary individual project
- MSc thesis project: large scale scientific multidisciplinary individual project
Details project based learning example

1st year BSc monodisciplinary group

Design focus

w = water, t = transport,
c = construction

Transport Engineering & Management
Master track

Entry Q1

<table>
<thead>
<tr>
<th>PS 1</th>
<th>PS2</th>
<th>OM 1</th>
<th>OM 2</th>
<th>ITS 1</th>
<th>ITS 2</th>
<th>MSc project</th>
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</thead>
<tbody>
<tr>
<td>E</td>
<td>E</td>
<td>VVR 2</td>
<td>VVR 12</td>
<td>VVR 6</td>
<td>Prep MSc</td>
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</tbody>
</table>

Entry Q3

<table>
<thead>
<tr>
<th>OM 1</th>
<th>OM 2</th>
<th>ITS 1</th>
<th>ITS 2</th>
<th>E</th>
<th>E</th>
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<tbody>
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PS = Planning & Sustainability
OM = Operations & Management
ITS = Intelligent Transport Systems
E = Elective

VVR 12 = Sustainable Transport Development
VVR 6 = Integral T&T Project
Experiences w.r.t. challenges (2)

- Acceptance of the multidisciplinary course in a *monodisciplinary* scientific environment (in view of professional certification, scientific accreditation, scientific publication opportunities)
  - accreditation relies on a smart design and clear philosophy
  - publication opportunities is a continuous battle of disciplines but evidence is provided
  - professional certification is absent in NL
- Creating and convincing job market
  - the job market is as good as the product
  - alumni can play the role of integrator, project manager or specialist

Example 3: need for multidisciplinarity

Water management deals with water systems
Water in the city

Large rivers
Sea and coast
Oceans

The southern delta

Source: Rijkswaterstaat
Water management deals with water systems

Sea and coast
Oceans

The southern delta

Water in the city

Large rivers

The wet heart
Water systems are used for a number of functions

Water management deals with watersystems

Source: Rijkswaterstaat
Emissions

Nature
Land Water interaction

Source: Ballast Nedam

Safety

Source: Rijkswaterstaat
Active (water) bottom management

Transport of ice, water and sediment
Water systems are used for a number of functions

Water management deals with watersystems

- shipping
- emissions
- nature
- land-water interaction
- safety
- active (water) bottom management
- transport of ice, water and sediment

Challenge for the water manager:

To achieve the (conflicting) objectives of the functions under technical and non-technical constraints!
Information supply and information demand for water management

Water management deals with water systems

Functions

Constraints technical / non-technical

Impacts due to human interference

Policy maker

Preferred state

Measures

Information supply and information demand for water management

Information supply
Water systems and Science

Information demand
Policy development and Implementation
Discussion