# Lesson Plans[[1]](#footnote-1)

## Day 1: Alternative Fuels in General (90 min)

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| **Phase** | **Content** | **Learning Activities of Students** | **Methodical Aspects** | **Materials** |
| **Introduction** | Introduction into the project and the context. PowerPoint presentation with pictures and information regarding the context. Teacher leads students through the presentation and creates motivation.  Students answer the questions of the teacher, who helps in case the students cannot answer. | …absorb information.  …answer teacher questions.  …describe pictures in the PowerPoint presentation. | teacher presentation  class discussion | beamer, laptop, PowerPoint presentation |
| **Brain-storming** | Teacher describes the current problem (no gas). Students think about how they can solve this problem. | …develop problem-solving hypothesis  🡪 produce an alternative fuel  …name the alternative fuels they know 🡪 ethanol, electricity, biodiesel, hydrogen, natural gas, etc.  …think about which alternative fuel would be most suited for their needs. | brainstorming in pairs  class discussion | blackboard, beamer, laptop, PowerPoint |
| **Working phase** | Teacher divides students into heterogeneous groups. Each group informs itself about one type of alternative fuel (natural gas, biodiesel, electricity, ethanol, hydrogen) using information texts and designs a poster with the relevant information. | …find out the use, production, advantages and disadvantages of their alternative fuel using information texts..  …learn vocabulary from the context and scaffolding.  …work out relevant information to solve the problem and answer questions.  …design a poster to present important information. | group work | worksheets: Information Texts on Alternative Fuels  posters, markers |
| **Reassurance phase** | Teacher corrects written English as well as content on the posters. Asks students questions about their topic. | …Students answer questions and accept advice and corrections to their poster. |  | posters |
| **Presenta-tions** | Each student presents their poster in newly formed groups (4 min per presentation) | …explain content as well as vocabulary on their poster.  …evaluate content and language decisions of peers.  …incorporate newly learned information into their knowledge about alternative fuels. | gallery walk | Posters, bell, scotch tape |
| **Review** | Students compare and evaluate alternative fuels in order to decide which are most suited for their needs and which they can produce at their current location. | …realize what are the advantages and disadvantages of alternative fuels.  … evaluate the problem and develop a list of necessary characteristics that the alternative fuel has to hast o be of use.  …categorize alternative fuels into two categories: useful, not useful in their situation. …decide on the alternative fuel most useful for the problem at hand. | brainstorming in pairs  class discussion | laptop, beamer, PowerPoint presentation |
| **Brain-storming** | Students think about how they can produce the alternative fuels. | …name reactants necessary for the production of alternative fuels.  …decide which alternative fuels can be produced under the climatic circumstances.  …think about which processes could be used for fuel production. | class discussion | laptop, beamer, PowerPoint presentation, posters |
| **End** | Teacher reviews the content of the lesson with the help of students. Gives a short preview of the next lesson. | …review the content of the lesson. | class discussion | laptop, beamer, PowerPoint presentation |

## Day 2: Production of Biodiesel and Ethanol (90 min)

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| **Phase** | **Content** | **Learning Activities of Students** | **Methodical Aspects** | **Materials** |
| **Introduction** | Summary of the contents, problems and solutions of the previous class to immerse students into the context again. Review of the results and procedures already mentioned. | …summarize contents of the previous lesson.  …name alternative fuels and their advantages and disadvantages.  …give ideas about the potential procedures for the production of biodiesel and ethanol. | class discussion | beamer, laptop, PowerPoint presentation |
| **Student**  **Experiment** | Students produce biodiesel and ethanol in their assigned groups. | …carry out experiments based on experimental procedures.  …understand unknown vocabulary based on context and illustrations.  …explain chemical processes in the separate steps during the experiment.  …use new experimental techniques.  … document their observations, procedure and analysis. | group work | beamer, laptop, PowerPoint presentation, chemicals and materials,  worksheets: Experimental Procedure, Lab Report Format, Laboratory Picture Dictionary, |
| **Reassurance phase** | Students explain their experiments to each other in pairs. | …describe their procedure.  …explain the necessary experimental steps and techniques for the synthesis. | group work | worksheets: Experimental Procedure |
| **Teacher Experiment** | Teacher combusts the produced fuels (biodiesel and ethanol) in comparison to diesel. | …compare the flashpoints of the three fuels.  …compare the emissions of combustion. …evaluate environmental harmfulness of alternative fuels. | class discussion | biodiesel, ethanol, diesel, fume hoods, Bunsen burner, matches, porcelain dishes |
| **Brain-storming/ Working phase** | Students decide which alternative fuel they will use to continue their journey. Teacher helps when necessary giving extra information about harmfulness, advantages and disadvantages of alternative fuels.  . | …discuss advantages and disadvantages of alternative fuels.  …think about why the fuels have different flash points.  …include new information into their knowledge. …evaluate which alternative fuel best suits their needs.  …give reasons for their decision. | brainstorming in pairs  class discussion | blackboard, beamer, laptop, PowerPoint presentation |
| **End** | Teacher reviews the content of the lesson with the help of students. Gives a short preview of the next lesson. „Arrival in Inuvik“ and successful problem-solving. | …review the content of the lesson. | class discussion | beamer, laptop, PowerPoint presentation |

## Day 3: Theoretical Background Knowledge (90 min)

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| **Phase** | **Content** | **Learning Activities of Students** | **Methodical Aspects** | **Materials** |
| **Introduction** | Summary of the contents, problems and solutions of the previous class to immerse students into the context again. Review of the results and production procedures of biodiesel and ethanol from the previous class. | …review content of the previous lessons.  …explain the production of biodiesel and ethanol.  … give reasons for their decisions in the previous lesson. | class discussion | beamer, laptop, PowerPoint presentation |
| **Establishing the problem** | Teacher asks questions about the theoretical background of the production of alternative fuels as well as their characteristic.  Students cannot give answers to all the questions. | …try to use their knowledge to explain theoretical backgrounds of alternative fuels.  …realize that they lack theoretical and scientific knowledge. | class discussion | beamer, laptop, PowerPoint presentation |
| **Working phase** | Students freely move from station to station to learn different contents. Each student works at his or her own pace (4 + 1 stations) | …calculate combustion enthalpies.  …use stoichiometry to solve questions.  …deduce content knowledge from information texts.  …recognize and identify reactants and products in the synthesis of biodiesel.  …deduce the synthetic pathway and structures from descriptions.  …interpret diagrams and pictures.  …analyze the harmfulness of alternative fuels based on emissions.  …compare harmfulness of alternative fuels based on emission life cycles.  …recognize when they require help and localize help cards or peers. | Learning by stations:  working alone or in groups | worksheets for each station, help cards |
| **Reassurance phase I** | Students check their results. | … check their results using answer keys. | working alone or in groups | answer key |
| **Reassurance phase II** | The students‘ understanding is checked by revision of the theoretical questions from the beginning of the class. Students answer questions. | …explain theoretical content of the lesson.  …review newly learned knowledge  …control their understanding.  …evaluate contents. | class discussion | beamer, laptop, PowerPoint presentation, worksheets |
| **End** | Teacher reviews the content of the lesson with the help of students. Gives a short preview of the next lesson. | …review the content of the lesson. | class discussion | beamer, laptop, PowerPoint presentation |

## Day 4: Discussion of and Dealing with a Current, Authentic Fuel Problem (90 min)

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| **Phase** | **Content** | **Learning Activities of Students** | **Methodical Aspects** | **Materials** |
| **Introduction** | Summary of the contents, problems and solutions of the previous classes to immerse students into the context again. Review of the results and procedures already mentioned.  Introduction to a new problem. | …summarize contents of the previous lesson. | class discussion | beamer, laptop, PowerPoint presentation |
| **Establishing the problem** | Students inform themselves about the new problem using a newspaper article. | …understand the new problem with the help of a newspaper article.  …deduce meaning of vocabulary from context.  ...describe the problem..  …analyze problem-solving strategies based on their knowledge about alternative fuels.  …create hypothesis of how to solve the problem. | working alone or in pairs | beamer, laptop, PowerPoint presentation, newspaper article |
| **Reassurance phase I** | Summary of all the possible ways of solving the problem. Consensus of which two alternative fuels could provide a solution. | …evaluation of the advantages and disadvantages of possible alternative fuels for this problem.  …decide on one solution. | class discussion | beamer, laptop, PowerPoint presentation, |
| **Working phase** | Teacher divides students into two groups (Group Fuel A, Group Fuel B)  Students find and summarize arguments for their fuel in groups. | …compare alternative fuels based on emissions.  …compare alternative fuels based on harmfulness and complexity of their synthesis.  …evaluate characteristics of alternative fuels as advantageous or disadvantageous under the circumstances.  … create arguments for their assigned fuel. | group work | all materials from the unit |
| **Fish-bowl discussion** | Students argue their point of view in two groups. . | … argue based on their arguments.  …evaluate statements of the discussion.  …form opinions on statements. | Fish-bowl discussion | discussion help |
| **Reassurance phase II** | Students give each other feedback. | …analyze content and language for correctness.  …evaluate which group had the stronger arguments.  …decided which alternative fuel is best suited for the situation at hand. | class discussion | chair circle |
| **End** | Teacher summarizes events and contents of the unit with the help of the students. Goodbye and return trip home. | …review contents of the unit. | class discussion | beamer, laptop, PowerPoint presentation |

1. All class materials that can be found online have been highlighted in blue. [↑](#footnote-ref-1)