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1 General introduction

The abstract is found at the beginning of a research article. It is a complete but concise and informative account of a research work. It is not merely a descriptive guide to the article, it also communicates the scope of the article and the topics discussed. It helps readers to determine whether the article will be relevant to them.

Linguistically, a well written abstract is characterized by being accurate, concise and specific, independent, objective, self-contained, etc.

An abstract usually consists of five central parts: 1) Background: the background and context of the study, its rationale and significance; 2) Problem: the particular research problem under investigation, the purpose of the study, and the specific research objective or hypothesis; 3) Method: the method used to investigate the problem, what was done or measured, and how was it done, the extent of the study, the location of the study and when it was performed; 4) Result: important data, major findings; 5) Conclusion: the implications of the result, future research directions, etc. Additional sections such as Objective (between Background and Method) and Limitation (at the end of the abstract) are found in some research articles.

2 Types of abstracts

There are four common abstracts: informative abstracts, indicative abstracts, structured abstracts, and graphical abstracts.

01 Informative abstracts

An informative abstract is a report in miniature, sketching out the whole article. It summarizes the key information from every major section of the article, and provides the key facts and conclusions. Usually this type of abstract devotes a sentence or two to each of the major parts of the article.

Example:

Electricity assisted anaerobic treatment of salinity wastewater and its effects on microbial communities

High salinity wastewater is often difficult to treat using common anaerobic technologies. Considering that high conductivity of salinity wastewater may enhance electrodes reaction to accelerate the decomposition of volatile fatty acids produced in anaerobic digestion, a pair of electrodes was packed into an anaerobic reactor (R1) with the aim to enhance the treatment of salinity wastewater. With increasing the salt concentration (NaCl) gradually from 0 to 50 g/L in 137 days' operation, COD removal in this reactor under the voltage for the electrodes of 1.2 V was well maintained at 93%, while the COD removal in a reference anaerobic reactor without electrodes (R2) decreased to 53%. When the voltage for R1 was cut off, about 10% COD removal was declined, which was still 30 percentage points higher than that in R2. The electrodes enhanced the biodegradation of volatile fatty acids, especially propionate. Fluorescence in situ hybridization analysis confirmed that the relative abundance of propionate-utilizing bacteria in R1 was significantly higher than that in R2. PCR-DGGE analysis of bacteria and archaea domains indicated that the electric field stimulation effectively enriched salt-adapted microorganisms during the treatment.

02 Indicative abstracts

An indicative abstract (sometimes called descriptive abstract) merely includes information about the purpose, scope, and method used in the study. It is to help readers understand the general nature and scope of the research article. It does not go into a detailed description of the process of the study.

Example:

Effects of development on monoterpene composition of *Hedeoma drummondii*

Samples of leaves, flowers and whole plants were taken from clonal stock of *Hedeoma drummondii* to determine the effect of developmental age on the monoterpene profile. GLC analysis revealed that there are significant differences in the quantity of major monoterpenes in leaves and flowers of different ages and in plants at different flowering stages. The results are discussed in relation to biogenetic pathways and implications for taxonomic work.

03 Structured abstracts

A structured abstract consists of a few paragraphs, each preceded by a subheading, similar to the original research article.

Example:

Accuracy of the Microsoft Kinect sensor for measuring movement in people with Parkinson's disease

Background: The Microsoft Kinect sensor (Kinect) is potentially a low-cost solution for clinical and home-based assessment of movement symptoms in people with Parkinson's disease (PD). The purpose of this study was to establish the accuracy of the Kinect in measuring clinically relevant movements in people with PD.

Methods: Nine people with PD and 10 controls performed a series of movements which were measured concurrently with a Vicon three-dimensional motion analysis system (gold-standard) and the Kinect. The movements included quiet standing, multidirectional reaching and stepping and walking on the spot, and the following items from the Unified Parkinson's Disease Rating Scale: hand clasping, finger tapping, foot, leg agility, chair rising and hand pronation. Outcomes included mean timing and range of motion across movement repetitions.

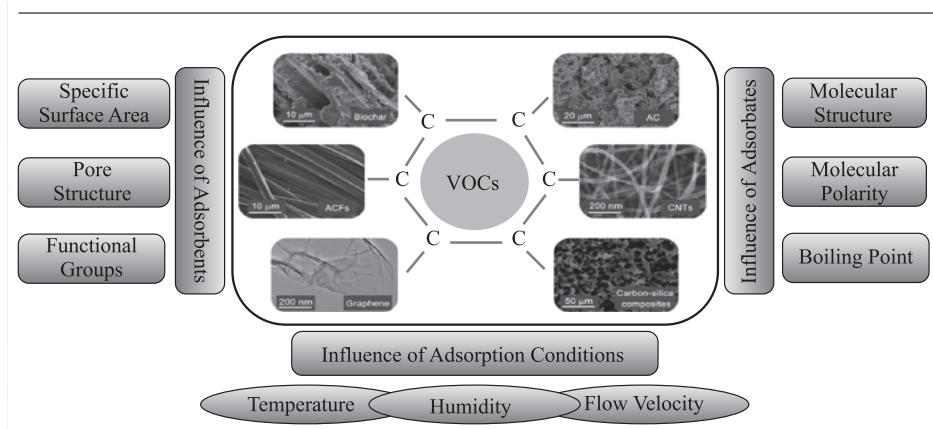
Results: The Kinect measured timing of movement repetitions very accurately (low bias, 95% limits of agreement < 10% of the group mean, ICCs > 0.9 and Pearson's $r > 0.9$). However, the Kinect had varied success measuring spatial characteristics, ranging from excellent for gross movements such as sit-to-stand (ICC = .989) to very poor for fine movement such as hand clasping (ICC = .012). Despite this, results from the Kinect related strongly to those obtained with the Vicon system (Pearson's $r > 0.8$) for most movements.

Conclusions: The Kinect can accurately measure timing and gross spatial characteristics of clinically relevant movements but not with the same spatial accuracy for smaller movements, such as hand clasping.

04 Graphical abstracts

A graphical abstract is a pictorial and visual summary of the main findings of the article. It could either be the concluding figure from the article or a figure that is specially designed for the purpose. It captures the content of the article for readers at a single glance.

Example:



3 Reading skills

While reading the abstract of a research article, you need to answer the following questions: Why was what was done done? What was done? How was it done? What was found? What was concluded?

In trying to find answers to these questions, you are actually identifying the five basic parts of an abstract: background, problem, method, result and conclusion. Very often an abstract does not contain all the five parts, sometimes omitting the background, or the conclusion, etc.

Usually, the background is written in the present tense, the research problem is presented either in the present tense or the past tense; the method and result are often written in the past tense, and the discussion and conclusion are written more often in the present and future tenses.

4 Sample analysis

01 Sample 1

Micropollutants removal from retentates generated in ultrafiltration and nanofiltration treatments of municipal secondary effluents by means of coagulation, oxidation, and adsorption processes

(1) One important disadvantage of using ultrafiltration (UF) and nanofiltration (NF) for reclamation of secondary effluents from municipal wastewater treatment plants (WWTPs) is the necessity to dispose of the UF and NF retentates. (2) Different advanced treatments including coagulation (iron and alum), oxidation (chlorine, permanganate and ozone) and powdered activated carbon (PAC) adsorption were compared for their efficiencies in removing 11 selected micropollutants and effluent organic matter (EfOM) from UF and NF retentates generated in the filtration of secondary effluents. (3) Ozone exhibited better micropollutants and UV₂₅₄ removal efficiencies than chlorine and permanganate. (4) Similar abatement of organics was observed when the same specific oxidant dose was applied to UF and NF retentates. (5) Coagulation preferentially removed high molecular weight compounds, being ineffective for the elimination of most micropollutants. (6) In general terms, iron coagulation was more efficient than alum, since iron achieved higher DOC and UV₂₅₄ removal at lower molar doses. (7) In addition, PAC was an effective method for removing micropollutants, especially hydrophobic and aromatic compounds. (8) The hybrid

Sentences (1) introduces the background: the disadvantage of one technique with the present tense.

Sentence (2) describes the research problem and method: by means of comparison, using past tense.

Sentences (3) - (7) describe the results: illustrating the compared results, using comparative degree and past tense.

coagulation/ozonation process improved micropollutants and EfOM (DOC and UV₂₅₄) removal. (9) A specific ozone dose of 1 mg O₃ mg DOC⁻¹ was able to almost completely remove selected micropollutants from the UF retentate. (10) The final effluent, which is likely more biodegradable and less toxic, could be recirculated to biological treatment processes in the WWTP, avoiding the continuous discharge of non-biodegradable micropollutants through the WWTP effluents.

Sentence (8) is the discussion and conclusion: using more future tense and subjunctive mood.

02 Sample Paper 2

Insights into the relationship between antimicrobial residues and bacterial populations in a hospital-urban wastewater treatment plant system

(1) The relationship between antimicrobial residues, antibiotic resistance prevalence and bacterial community composition in hospital effluent and in the receiving wastewater treatment plant was studied. (2) Samples from hospital effluent, raw inflow and final effluent of the receiving wastewater treatment plant were characterized for amoxicillin and ciprofloxacin resistance prevalence, content of heavy metals and antimicrobial residues and bacterial community structure, based on 16S rRNA gene PCR-DGGE analysis. (3) The concentration of fluoroquinolones, arsenic and mercury was in general higher in hospital effluent than in raw inflow, while the opposite was observed for tetracyclines, sulfonamides and penicillin G. (4) The prevalence of ciprofloxacin resistance was significantly higher in hospital effluent than in raw inflow. (5) The concentration of antimicrobial residues was observed to be significantly correlated with the prevalence of antibiotic resistant bacteria and with variations in the bacterial community. (6) Hospital effluent was confirmed as a relevant, although not unique, source of antimicrobial residues and antibiotic resistant bacteria to the wastewater treatment plant. (7) Moreover, given the high loads of antibiotic residues and antibiotic resistant bacteria that may occur in hospital effluents, these wastewater habitats may represent useful models to study and predict the impact of antibiotic residues on bacterial communities.

Sentence (1) tells the research problem: what was done in the study, using the past tense.

Sentence (2) describes the method: how samples were characterized, with the past tense.

Sentences (3)-(6) describe the results and discussion, describing the results by comparative degree forms, using past tense.

Sentence (7) indicates what these results might imply using subjunctive mood.



READING PRACTICE

- 1 Read the following abstract, and try to identify the five components of the abstract: the background, the research problem, the method, the results and the conclusion.

Harnessing big data for estimating the energy consumption and driving range of electric vehicles

(1) Analyzing the factors that affect the energy efficiency of vehicles is crucial to the overall improvement of the environmental efficiency of the transport sector, one of the top polluting sectors at the global level. (2) This study analyses the energy consumption rate (ECR) and driving range (DR) of battery electric vehicles (BEVs) and provides insight into the factors that affect their energy consumption by harnessing big data from real-world driving. (3) The analysis relied on four data sources: (i) driving patterns collected from 741 drivers over a two-year period; (ii) drivers' characteristics; (iii) road type; (iv) weather conditions. (4) The results of the analysis measure the mean ECR of BEVs at 0.183 kWh/km, underline a 34% increase in ECR and a 25% decrease in DR in the winter with respect to the summer, and suggest the electricity tariff for BEVs to be cost efficient with respect to conventional ones. (5) Moreover, the results of the analysis show that driving speed, acceleration and temperature have non-linear effects on the ECR, while season and precipitation level have a strong linear effect. (6) The econometric model of the ECR of BEVs suggests that the optimal driving speed is between 45 and 56 km/h and the ideal temperature from an energy efficiency perspective is 14°C. (7) Clearly, the performance of BEVs highly depends on the driving environment, the driving patterns, and the weather conditions, and the findings from this study enlighten the consumers to be more informed and manufacturers to be more aware of the actual utilization of BEVs.

- 2 According to the components and their sequence appearing in an abstract, order the sentences below to form an abstract.
- A The participants were 30 volunteer students, 15 male and 15 female who have recently graduated from the Biology Department of Red Tree University. (Method)
 - B The participants were asked what influence biology education has on their attitudes regarding world peace and humanity. (Method)
 - C The results indicated that biology education has some positive impacts on attitudes of the students regarding humanity and world peace. (Conclusion)

- D The responses of the participants indicated that, at the end of four-year biology education, they have more self-awareness and have greater capacity to love human beings and all the living creatures. (Result)
- E The aim of this study was to examine whether biology education has any impacts on attitudes in terms of humanity and world peace. (Purpose)
- F In addition, they reported they had the feeling that they could contribute to the world peace. (Result)
- G Biology has always been a beneficial discipline for the human beings. (Background)