HONG KONG BAPTIST UNIVERSITY
Faculty of Science

1. **Course Code and Course Title**
GFQR1055 Sharpening Your Number Sense with Handy Computational Tools (3,3,0)

2. **No. of Units**
3

3. **Offering Department**
Department of Mathematics

4. **Pre-Requisite**
Nil

5. **Co-Requisite / Anti-Requisite (if any)**
Nil

6. **Aims & Objectives**

This course aims at developing students' skills in managing and reasoning with quantitative data to tackle real-life challenges. Students will learn to provide quantitative evidence by data handling and analysis via computational tools that organize and analyse data in tabular form. These tools, including online calculators, and spreadsheet software such as MS Excel and Google Sheets are common and widely used in the academic and business world, when people make decisions based on quantitative reasoning.

Students will be given authentic tasks in accounting, commercial, financial, medical and some other selected disciplines and guided to use software to complete these tasks efficiently and draw conclusion with convincing reasoning. Both explicit quantitative problems and problems that are not so obviously quantitative will be given so that students will learn to formulate them with quantitative methods in general. Students should be able to draw conclusions and present them with strong reasoning supported by results in numbers.

7. **Course Intended Learning Outcomes (CILOs)**

CILO	By the end of the course, students should be able to:	PILOs
1	Identify quantitative real-life problems, both contemporary and historical, and from various disciplines and cultures.	1,5
2	Solve practical problems in various disciplines with quantitative analysis.	2,3,4
3	Use appropriate computational tools or software to help accomplish large-scale tasks in real-life.	2,3
4	Effectively communicate quantitative reasoning.	2,3,4,5

8. **Teaching & Learning Activities (TLAs)**

CILO No.	TLAs
1,2	**Lectures** The instructor will present real-life examples taken from different disciplines, such as accounting, commerce, finance, medicine, history and culture to motivate students' interests. The instructor will explain the reasons behind quantitative formulation of real-life problems and draw convincing conclusion supported by quantitative results, followed by illustrations of practical examples for finer details. Different cases, ranging from simple to complicated scenarios, will be introduced and discussed, in order to develop and strengthen students' reasoning skills and ability required for solving related problems.
1,2,4	**In-class activities** During classes, students have the opportunity to participate in activities of various forms, including discussions, in-class exercises and software practice. For example, before discussing the lecture materials, the instructor will present relevant scenarios to motivate students and initiate discussions so that students can express their own opinion on how to formulate the problems and what quantitative evidence they are looking for. The scenarios also enhance students' problem-solving skills via discussion with classmates under the guidance of the instructor/tutor, who will observe and jump in their discussion in classes. Exercises on producing quantitative evidence that they are looking for will be given so that students can practice right after learning the relevant knowledge in the lecture. Students can also seek immediate help from instructor/tutor. Real-life authentic tasks from various disciplines will be required to be completed in classes. Students may first discuss with each other to figure out the difficulties and some possible solutions. The instructor/tutor will observe and provide directions, if needed. Students will then perform the real-time programming tasks independently. Feedback will be given after the completion of work. The discussions also enable students to voice out their own real-life difficulties, could be but not limited to be obviously quantitative, and explore the possibility of solving their own or others' problems quantitatively. In the process they may come up with some topics for the case studies and may form groups with those who have similar interests. With students from various backgrounds, instructor/tutor would facilitate discussions on differing value systems among different disciplines and guide students to apply this to the decision making process.
1,2,3	**After-class activities** Students are required to work on assigned tasks after class and are expected to have further discussions with the instructor. Students will be asked to solve problems arising from various scenarios, for which they need to explore deeper into the topics. Students need to formulate the problems, identify and use appropriate computational tools or software to solve the problems, and then draw a convincing conclusion based on the results. This allows students to consolidate their knowledge and reasoning skills and apply them to different scenarios.

1,2,3,4	**Student-oriented case study** Students work in small groups of size 3-5 with members from different majors in a real-life case study, possibly selected from in-class discussions, and design a comprehensive spreadsheet for solving a large-scale problem. Students shall introduce the work in their case study, and explain their formulation and conclusion supported by their own quantitative analyses to the class and take part in discussing and improving others' projects via exchange of ideas. This allows students to develop their collaboration and communication skills regarding quantitative formulation and reasoning.

9 **Assessment Methods (AMs)**

Type of Assessment Methods ABC	Weighting	CILOs to be Address	Description of Assessment Tasks
In-class exercises	20%	1,4	In-class exercises on the use of computational tools or software to produce quantitative evidence will serve as a formative continuous assessment so that students can practice right after learning some new knowledge in the lectures. In most in-class exercises, students can discuss with classmates and seek immediate help from the instructor/tutor. Some independent in-class exercises require student to complete by his/herself solely without communication with others. There will be 7 in-class exercises (weight 2% each), and 2 independent in-class exercises (weight 3% each). Each of them allows the students to know what they do well and what they need to work harder on. In particular, independent in-class exercises can test students' specific knowledge of aspects of Excel. It also allows the instructor to identify the learning needs and problems of students.
Homework Assignments	20%	1,2,3	Problems arising from various scenarios will be given. Students need to formulate the problems and solve the problems supported by quantitative analyses. Students are required to make conclusion based on the evidence that they produced and provide convincing reasons. There will be 4 assignments. Each of them allows the instructor to keep track of how well the students master the knowledge and skills covered during different stages of the course.
Project	20%	1,2,3,4	Students work in groups of 3-5 with members from different majors. Students investigate a real-life case and design a comprehensive spreadsheet

			for solving a large-scale problem. Students shall collaborate on the online computational tools or software so that the instructor could keep track of the contribution of each student. A written report is required together with the program(s) and/or software file(s). If programs/files are generated by AI tools, students are required to explain the process how they instruct the AI to produce the programs/files and how they verify the correctness of the programs/files. The project allows the instructor to assess how well students perform according to the following criteria: (4%) ability to formulate real-life problems quantitatively, (4%) appropriateness of the approaches, (4%) accuracy and completeness of solutions, (4%) persuasiveness of conclusions, (4%) contribution to the project (individual grades will be given).
Presentation	20%	2,4	Students present their work to classmates, demonstrate how to produce and use quantitative evidence to solve a practical problem, and explain why their solution works. Each group presentation will be followed by a discussion session. Students are required to take part in discussing and improving others' projects via exchange of ideas. Each student is expected to take part in the discussion of multiple sessions although it may not be necessary for everyone to speak in every session. The presentation allows the instructor to assess how well students perform in the following criteria: (5%) accuracy of quantitative reasoning content, (5%) effectiveness of the demonstration, (5%) innovation and creativity of the presentation, (5%) ability to comment on and give good suggestions to others' projects (individual grades will be given).

Real-time programming	20%	1,2,3	The real-time programming is a summative assessment of students' performance in multiple components of the course. Students are required to use computational tools or software that have been used for demonstration in class to solve a real-life problem in an internet-off and help-function-on situation. It means students can access the descriptions of different functions offered by the software producer, but they are expected to complete the programming independently. Students are required to make conclusion base on the quantitative evidence they produced and provide convincing reasons. There will be 2 real-time programming tasks. Each of them allows the instructor to assess how well students master the skills and technique in using computational tools or software to solve problems and draw conclusions independently.

10. **Assessment Rubrics**

CILO1: Identify quantitative real-life problems, both contemporary and historical, and from various disciplines and cultures.

Criteria	Excellent	Good	Satisfactory	Marginal Pass	Fail
Identification	Complete identification of quantitative real-life problems of various disciplines with accurate terms and/or values.	Identification of most of the quantitative real-life problems of various disciplines with some accurate terms and/or values.	Identification of some quantitative real-life problems of various disciplines with a few accurate terms and/or values.	Attempt in identification of quantitative real-life problems of various disciplines with mostly inaccurate terms and/or values.	Inappropriate identification of quantitative real-life problems of various disciplines with no terms and/or values.

CILO 2: Solve practical problems in various disciplines with quantitative analysis.

Criteria	Excellent	Good	Satisfactory	Marginal Pass	Fail
Solution	Thorough and elegant solution of practical problems with valid discussions, justifications, verifications, and appraisals of the underlying quantitative analysis.	Appropriate solution of practical problems with some valid discussions, justifications, verifications, and appraisals of the underlying quantitative analysis.	Reasonable solution of practical problems with a few valid discussions, justifications, verifications, and appraisals of the underlying quantitative analysis.	Attempt in solving the practical problems with limited discussions, justifications, verifications, and appraisals of the underlying quantitative analysis.	Inappropriate solution of practical problems with no discussion, justification, verification, or appraisal of the underlying quantitative analysis.

CILO 3: Use appropriate computational tools or software to help accomplish large-scale tasks in real-life.

Criteria	Excellent	Good	Satisfactory	Marginal Pass	Fail
Application	Insightful, clear, and complete applications of computational tools or software to accomplish large-scale tasks in real-life.	Appropriate and clear applications of computational tools or software to accomplish some large-scale tasks in real-life.	Reasonably clear applications of computational tools or software to accomplish a few large-scale tasks in real-life.	Attempt in applications of computational tools or software to accomplish tasks in real-life.	Inappropriate applications of computational tools or software to accomplish tasks in real-life.

CILO 4: Effectively communicate quantitative reasoning.

Criteria	Excellent	Good	Satisfactory	Marginal Pass	Fail
Communication	Sophisticated communication with a high degree of coherence and organization; clear introduction, transitions, and conclusion; with valid and accurate quantitative reasoning.	Appropriate communication with a considerable degree of coherence and organization; missing a few important elements; with mostly valid and accurate quantitative reasoning.	Reasonable communication with some degree of coherence and organization; missing some important elements; with some misuse of quantitative reasoning.	Attempt in communication with limited degree of coherence and organization; missing most of the important elements; with mostly misuse of quantitative reasoning.	Inappropriate communication with no degree of coherence and organization; missing important elements; with overwhelmingly misuse of quantitative reasoning.

11. Course Intended Learning Outcomes and Weighting

Content	CILO No.	Teaching (in hours)
1. Why they are the targets	1, 4	3
2. Why one can earn more with spending less	1, 2, 3, 4	9
3. Why text is quantitative	1, 2, 3, 4	3
4. Why it is better	1, 2, 3, 4	12
5. Why misleading charts could be produced by honest data	2, 3, 4	6
6. Case studies of real-life usage in various disciplines	1, 2, 3, 4	6

12. Textbooks / Recommended Readings

General Reading List and References:

1.	Simpson-Wolf, A. (2013). Customer Needs Identification. *Electrical and Computer Engineering Design Handbook, 2013.* Retrieved from https://sites.tufts.edu/eeseniordesignhandbook/2013/customer-needs-identification-2/ on March 23, 2023.

2.	Csató, L. (2022). A Comparative Study of Scoring Systems by Simulations. *Journal of Sports Economics, forthcoming, 2022.* DOI: 10.1177/15270025221134241. Preprint available at arXiv:2101.05744.
3.	Pindar, J. (2023). *Financial Wellbeing Statistics: UK 2023.* Retrieved from https://championhealth.co.uk/insights/financial-wellbeing-statistics/ on March 22, 2023.
4.	Rexin, T. and Porter, M. (2021). Finding Your Way: Shortest Paths on Networks. *Frontiers for Young Minds*. 9:631045. DOI: 10.3389/frym.2021.631045.
5.	Ives, G. (2020). *Non-Numeric Data Visualisation*. University of Sheffield. Retrieved from https://dataviz.shef.ac.uk/blog/20/05/2020/Non-Numeric on March 10, 2023.
6.	Hong Kong Population History. Retrieved from http://www.demographia.com/db-hkhist.htm on June 29, 2022.
7.	Liu, K. I. and To, K. M. (2014). *Speaking of Statistics*. Pearson, Hong Kong.
8.	*ChatGPT for Data Analysts*. Retrieved from https://www.ironhack.com/ww/en/blog/chatgpt-for-data-analysts on March 10, 2023.
9.	Knaflic, C. N. (2015). *Storytelling with Data: A Data Visualization Guide for Business Professionals*. John Wiley & Sons, Hoboken, New Jersey.
10.	Maddigan, P. and Susnjak, T. (2023). *Chat2VIS: Generating Data Visualisations via Natural Language using ChatGPT, Codex and GPT-3 Large Language Models*. DOI: 10.48550/arXiv.2302.02094.

13. **Course Content**

Topic	Contact Hours
Week 1 **Why they are the targets** Students will learn how to sort out their target potential society members/ audience/ customers and the reason why they are the targets. **Skills:** Presenting, extracting, and managing data stored in various formats to identify potential quantitative evidence **Lecture:** Explore some practical tasks from or similar to those in the following list:	3 Hours

A. Practical task: presentable customers' record to be shared to different departments, in which the raw data are in various formats, different order, and with low quality. The instructor will focus on how to tidy up data in high quality, and the reason why high quality data favor quantitative management. B. Practical task: figuring out target customers satisfying certain conditions, for example, living in a certain district, spending over 10k per year. **In-class exercise 1:** Provide quantitative reasons and solutions to given scenarios with elementary data manipulation. **Reading:** • Simpson-Wolf, A. (2013). Retrieved from https://sites.tufts.edu/eeseniordesignhandbook/2013/customer-needs-identification-2/	
Weeks 2-4 **Why one can earn more with spending less** Students will learn how to make decisions based on quantitative evidence to maximise the profit or minimize the cost, and the reason why one can earn more with spending less. **Skills:** Carrying out computations using formulas and functions for producing nontrivial quantitative evidence **Lecture:** Explore some practical tasks from or similar to those in the following list: A. Practical task: accounting reports in retail store which summarise the income, expenditure and debt. The instructor will focus on drawing conclusions about the financial health of the store supporting by the results. B. Practical task: score allocation in different games, such as single round-robin competition, double round-robin competition, Swiss system tournament, etc. The instructor will focus on the reasons why particular	9 Hours

scoring system may benefit some teams.

C. Practical task: choosing path for transportation subject to various constraints and objectives such as minimising the time, distance, cost, or other factors.

In-class exercises 2 and 3: Provide quantitative reasons and solutions to given scenarios with evidence resulted from computation.
Discussions: Students' own real-life difficulties

Assignment 1: Daily-life problems involving large amounts of repetitive computations
The scenario may be

- to combine two small interest societies and to set target of promotion to reach potential new members. The conclusion is expected to be supported by strong reasoning.
- to minimise the time to reach all check points for a treasure hunt in university orientation. The conclusion is expected to be supported by strong reasoning.
- to maximise the chance of winning by choosing the favorite scoring system when organising a joint university competition. The conclusion is expected to be supported by strong reasoning.

Real-time programming 1: Handling repetitive computations and draw conclusion based on the results.

Progress of project: students formed groups and selected their topic of the case study

Reading:

- Csató, L. (2022). DOI: 10.1177/15270025221134241
- Pindar, J. (2023). Retrieved from https://championhealth.co.uk/insights/financial-wellbeing-statistics/
- Rexin, T. and Porter, M. (2021). DOI: 10.3389/frym.2021.631045

Week 5 **Why text is quantitative** Students will learn how to identify the patten of text so that repetitive comparison/copy-and-paste could be done by a few iterations, and the reason why text is quantitative. **Skills:** Manipulating non-numerical data for the extraction of quantitative evidence **Lecture:** Explore some practical tasks from or similar to those in the following list: A. Practical task: identify changes among different year plans. B. Practical task: personalised messages to members of an organisation, such as generating reminder messages to members about their own individual meeting timeslots. C. Practical task: event planning with automatic update of data in case something has been changed. The instructor will focus on why quantitative properties of text data favor text data management. **In-class exercise 4:** Provide quantitative reasons and solutions to given non-numerical data and problems. **Reading:** • Ives, G. (2020). Retrieved from https://dataviz.shef.ac.uk/blog/20/05/2020/Non-Numeric	3 Hours
Weeks 6-9 **Why it is better** Students will learn how to compute statistics and to make comparisons, and the reason why an assessment/product/method is better. **Skills:** Analysing data to produce statistical evidence	12 Hours

Lecture:

Explore some practical tasks from or similar to those in the following list:

A. Practical task: item analysis of students' performance in a test, to figure out what topic students are weak in, what misconception students have etc.
B. Practical task: displaying financial transactions in categories, to display by date, by bank, by transaction amount or by other categories.
C. Practical task: evidencing the improvement brought by a new medical treatment, to claim statistically a new medical treatment is better than the traditional one.

Online calculators for commonly used distributions will be introduced. The instructor will focus on drawing conclusions supported by statistical evidence.

Independent in-class exercise 1: Compare given objects and explain which is better with quantitative evidence.

In-class exercises 5 and 6: Provide quantitative reasons and choose the best one in given scenarios with statistical evidence.

Assignments 2-3: Daily-life problems involving analysis of large amounts of quantitative data

The scenario may be

- to send invitation email to individuals for a ceremony. Their decision on choosing the procedure is expected to be supported by strong reasoning.
- to compare the seriousness of COVID-19 in different countries. The conclusion is expected to be supported by strong reasoning.

Real-time programming 2: Analytical problems involving cross referencing functions, and the use of statistical functions in formulas

Progress of project: students studied their selected case and look for quantitative evidence

Reading:

• Liu, K. I. and To, K. M. (2014). *Speaking of Statistics* • *ChatGPT for Data Analysts*. Retrieved from https://www.ironhack.com/ww/en/blog/chatgpt-for-data-analysts	
Weeks 10-11 **Why misleading charts could be produced by honest data** Students will learn how to honestly visualise data by formatting and charting and to distinguish dishonest presentations, and the reason why misleading charts could be produced by honest data. **Skills:** Visualising data and results via their quantitative properties to produce visualisable quantitative evidence **Lecture:** Explore some practical tasks from or similar to those in the following list: A. Practical task: identifying changes in a curriculum reform, to visualise the whole image without looking in the details. B. Practical task: presenting results in customer survey, to visualise results in charts and to understand misuses of charts. C. Practical task: visualising data of Hong Kong population in previous decades and explain the growth and decay by historical reasons. D. Practical task: guiding a school child to explore areas of polygons and circles, in which a child could input the number of sides of a polygon to see the corresponding polygon with the area calculated and could be able to increase the number of sides to see a close-to-circle shape with the area calculated. **In-class exercise 7:** Visualise quantitative evidence to given problems. **Independent in-class exercise 2:** Visualise quantitative evidence to given problems. **Assignment 4:** Daily-life problems involving visualisation of data and results	6 Hours

The scenario may be - to visualise the results of a survey after conducting an event and to produce favorable charts. Their decision is expected to be supported by strong reasoning. - to criticise the dishonesty of a commercial chart on advertisement. The arguments are expected to be supported by strong reasoning. **Progress of project:** students finalised their work and prepared for the presentation **Reading:** • *ChatGPT for Data Analysts*. Retrieved from https://www.ironhack.com/ww/en/blog/chatgpt-for-data-analysts • *Hong Kong Population History.* Retrieved from http://www.demographia.com/db-hkhist.htm • Knaflic, C. N. (2015). *Storytelling with Data: A Data Visualization Guide for Business Professionals* • Maddigan, P. and Susnjak, T. (2023). DOI: 10.48550/arXiv.2302.02094	
Weeks 12-13 **Case studies of real-life usage in various disciplines** Presentation and discussion of case studies of real-life scenario Timeline Weeks 2-4: students form groups and start selecting their topic of the case study Weeks 5-9: students study their selected case and look for quantitative evidence Weeks 10-11: students finalise their work and prepare for the presentation Weeks 12-13: presentations to the class and participating in discussions for improving others' projects via exchange of ideas.	6 Hours
Total:	**39 Hours**

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Approved by General Education Committee meeting on 29 March 2023.

Approved by General Education Committee meeting on 21 April 2023.

Approved by Faculty Board meeting on 17 May 2023.