Faculty of Civil Engineering

Motivation Towards Learning Computational Thinking: Tertiary Education Case Study

R. Robert Gajewski

TOC

- Introductory (historical) remarks
- From IT to CT
- About motivation
- How to measure motivation?
- My survey and its results
- Final remarks

- Discussion

Evolution vs Revolution

- Information Technologies

- Applied Computer Science

- Computing & Computational Thinking

25 years…

Gajewski Ryszard Robert: Computer assisted teaching: from automatic testing to hypermedia techniques, w: Metody Komputerowe w Inzynierii Ladowej, nr 1, 1995, ss. 73-86

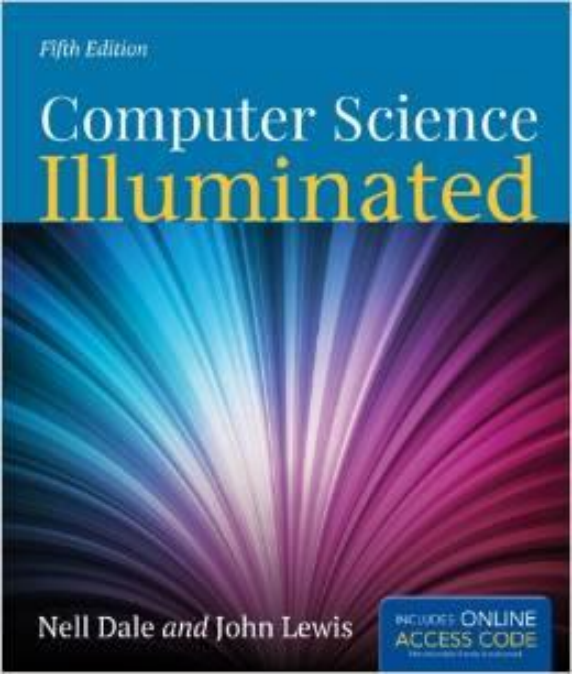
Dzierżak M., Zieliński S., Jankowska Anna *[i in.]*: Computer aided multiply choice tests for computational and structural mechanics, w: Proceedings of the XII Polish Conference on Computer Methods in Mechanics, 1995, Wydawnictwa Politechniki Warszawskiej

Gajewski Ryszard Robert, Witkowski Marek: The usage of hypertext techniques in teaching of the finite element method, w: Proceedings of the XII Polish Conference on Computer Methods in Mechanics, 1995, Wydawnictwa Politechniki Warszawskiej

Phases…

- Tests
- Multimedia materials
- Flipped classroom
- Cheating and e-Cheating
- Flowcharting tool
- Active presentations

- Lack of motivation?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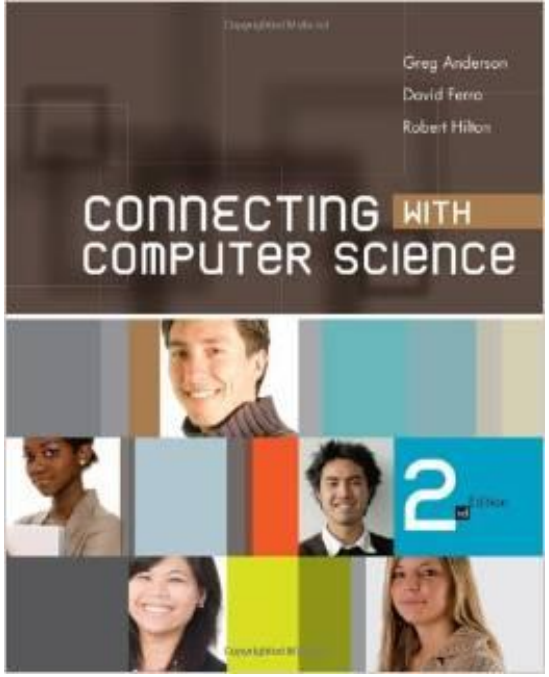
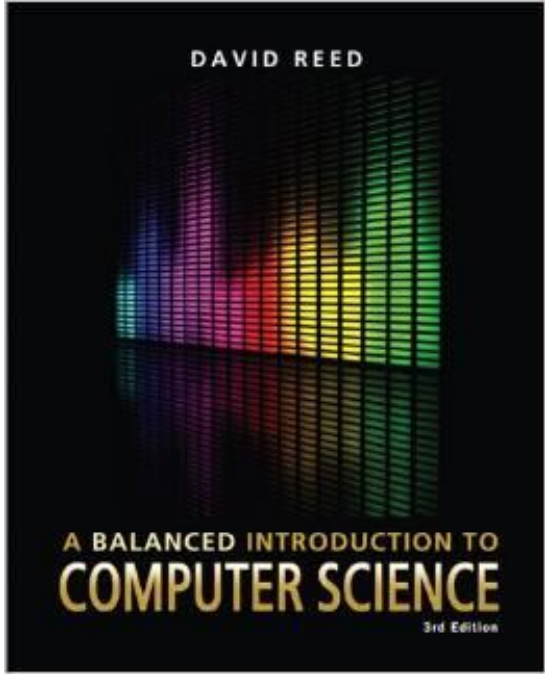
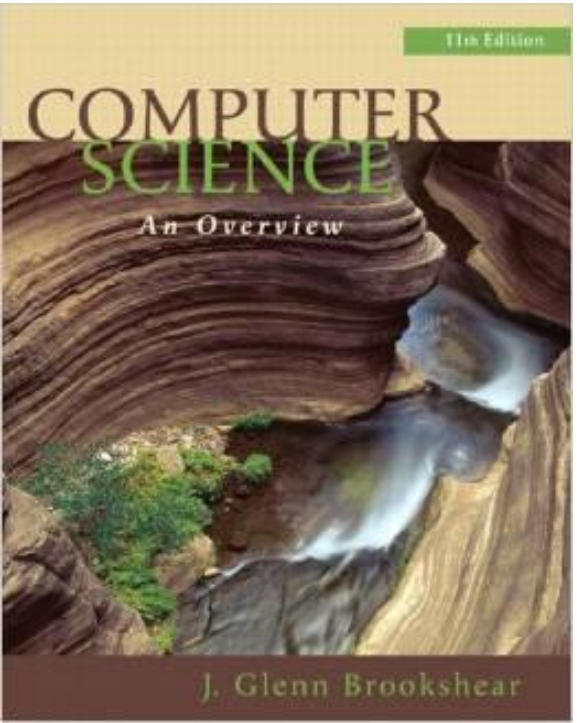
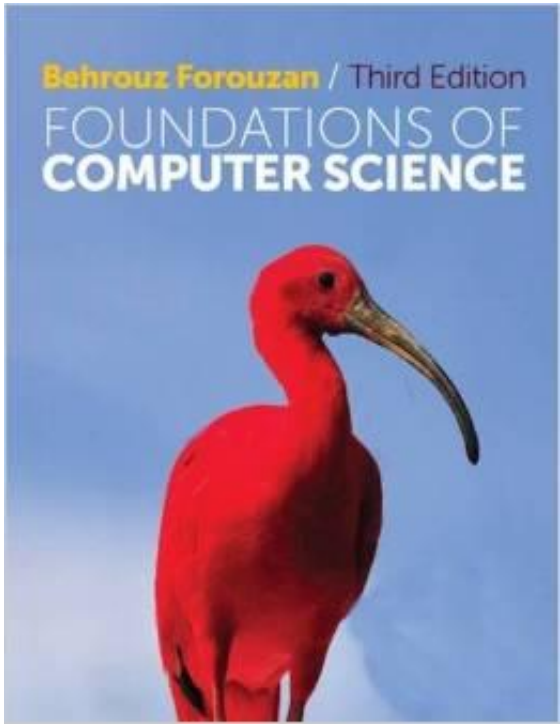

Greg Anderson
David Ferro
Robert Hilton
CONNECTING WITH COMPUTER SCIENCE
2nd


DAVID REED
A BALANCED INTRODUCTION TO
COMPUTER SCIENCE
3rd Edition


11th Edition
COMPUTER SCIENCE
An Overview
J. Glenn Brookshear


INVITATION TO
COMPUTER
SCIENCE
SEVENTH EDITION
G. Michael Schneider & Judith L. Gersting


Behrouz Forouzan / Third Edition
FOUNDATIONS OF
COMPUTER SCIENCE

Invitation to Computer Science	Computer Science Illuminated	Computer Science: An Overview	Balanced Introduction to Computer Science	Connecting with Computer Science	Foundations of Computer Science
1. An Introduction to Computer Science.	1 The Big Picture	0 Introduction	1 Computer Basics	1. History and Social Implications of Computing.	1. Introduction
2. Algorithm Discovery and Design.	2 Binary Values and Number Systems	1 Data Storage	2 HTML and Web Pages	2. Computing Security and Ethics.	2. Number Systems
3. The Efficiency of Algorithms.	3 Data Representation	2 Data Manipulation	3 The Internet and the Web	3. Computer Architecture.	3. Data Storage
4. The Building Blocks: Binary Numbers, Boolean Logic, and Gates.	4 Gates and Circuits	3 Operating Systems	4 JavaScript and Dynamic Web Pages	4. Networks.	4. Operations on Data
5. Computer Systems Organization.	5 Computing Components	4 Networking and the Internet	5 JavaScript and User Interaction	5. The Internet.	5. Computer Organization
6. An Introduction to System Software and Virtual Machines.	6 Low-Level Programming Languages and Pseudocode	5 Algorithms	6 The History of Computers	6. Database Fundamentals.	6. Computer Networks and Internet
7. Computer Networks and Cloud Computing.	7 Problem Solving and Algorithms	6 Programming Languages	7 Functions and Randomness	7. Numbering Systems and Data Representations.	7. Operating Systems
8. Information Security.	8 Abstract Data Types and Subprograms	7 Software Engineering	8 Algorithms and Programming Languages	8. Data Structures.	8. Algorithms
9. Intro to High Level Languages	9 Object-Oriented Design and High-Level Programming Languages	8 Data Abstractions	9 Abstraction and Libraries	9. Operating Systems.	9. Programming Languages
10. The Tower of Babel: Multiple Programming Voices.	10 Operating Systems	9 Database Systems	10 Computer Science as a Discipline	10. File Structures.	10. Software Engineering
11. Compilers and Language Translation.	11 File Systems and Directories	10 Computer Graphics	11 Conditional Execution	11. Human-Computer Interface.	11. Data Structures
12. Models of Computation.	12 Information Systems	11 Artificial Intelligence	12 Data Representation	12. Problem Solving and Debugging.	12. Abstract Data Types
13. Simulation and Modeling.	13 Artificial Intelligence	12 Theory of Computation	13 Conditional Repetition	13. Software Engineering.	13. Files Structures
14. Electronic Commerce.	14 Simulation, Graphics, Gaming, and Other Applications		14 Inside the Computer–The von Neumann Architecture	14. Programming I.	14. Databases
15. Artificial Intelligence.	15 Networks		15 JavaScript Strings	15. Programming II.	15. Data Compression
16. Computer Graphics and Entertainment:	16 The World Wide Web		16 Inside the Computer–Transistors and Integrated Circuits		16. Security
17. Making Ethical Decisions	17 Computer Security		17 JavaScript Arrays		17. Theory of Computation
	18 Limitations of Computing		18 Computers and Society		18. Artificial intelligence

Graphics

- Formats and compression
- Vector graphics
- …

Word & CT

- TOC
- Bibliography
- Pattern replacement
- …

Excel & CT

- Text operations
- If statement
- Iterative calculations
- Database functions
- …

Prime & CT

- Symbolic and numeric calculations
- Solve Block
- Programming
- …

Introduction to computational thinking

Before computers can be used to solve a problem, the problem itself and the ways in which it could be resolved must be understood. Computational thinking techniques help with these tasks.

Revise | Test

< 1 2 >

What is computational thinking?

Computers can be used to help us solve problems. However, before a problem can be tackled, the problem itself and the ways in which it could be solved need to be understood.

Computational thinking allows us to do this.

More Guides

Introduction to computational thinking

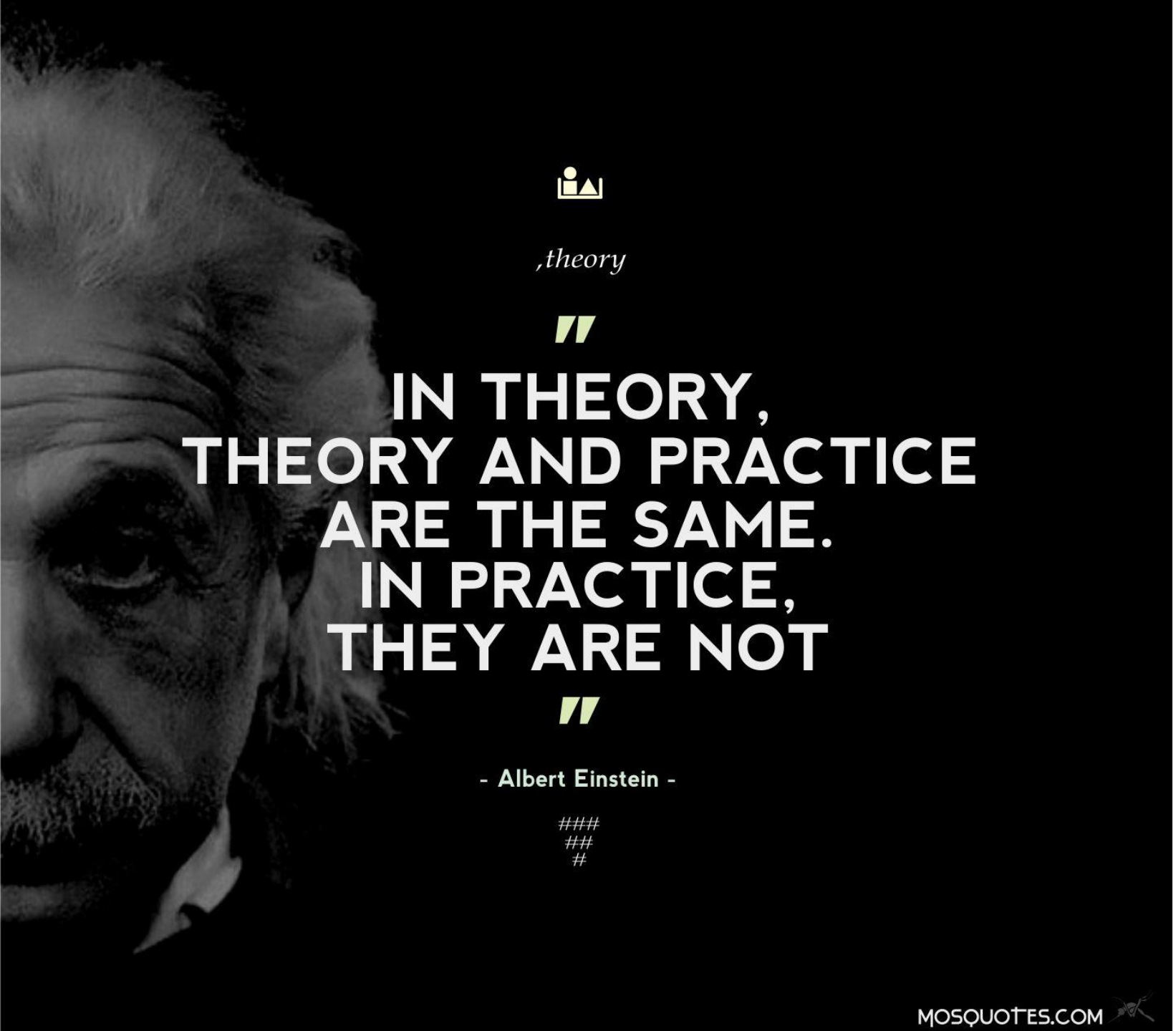
Decomposition >

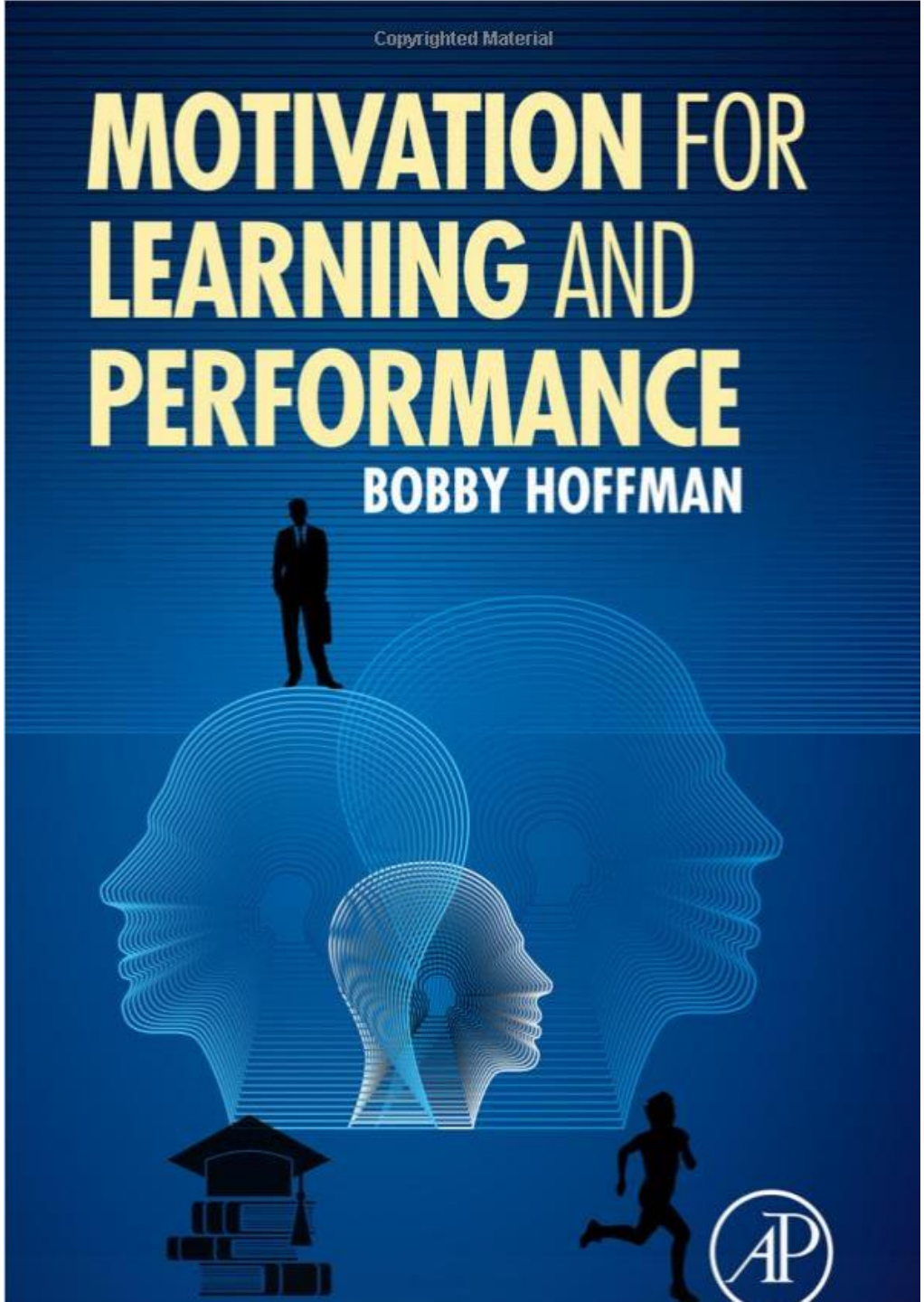
Pattern recognition >

Abstraction >

Algorithms >

Evaluating solutions >


,theory
IN THEORY,
THEORY AND PRACTICE
ARE THE SAME.
IN PRACTICE,
THEY ARE NOT
- Albert Einstein -
MOSQUOTES.COM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MOTIVATION FOR LEARNING AND PERFORMANCE
BOBBY HOFFMAN
AP

Measuring Motivation

A measure was considered reliable if tests of stability, equivalence, or internal consistency yielded reliability coefficients > .70. Qualitative measures were considered reliable if adequate inter-rater reliability was reported. Sources of validity evidence were evaluated through examination of instrument content, reported internal structure of test items, and indices of convergent, discriminate, or covariance evidence (p. 107).

Measures are listed alphabetically according to the construct(s) assessed, followed by the instrument name and type. Empirical examples signify either an empirical study using the measurement method or the source of instrument design and validation. Psychometric information indicates the procedures to determine reliability and validity. Potential usage indicates the specific sample used to validate the measure and/or how the measure has been used in practice.

References

References

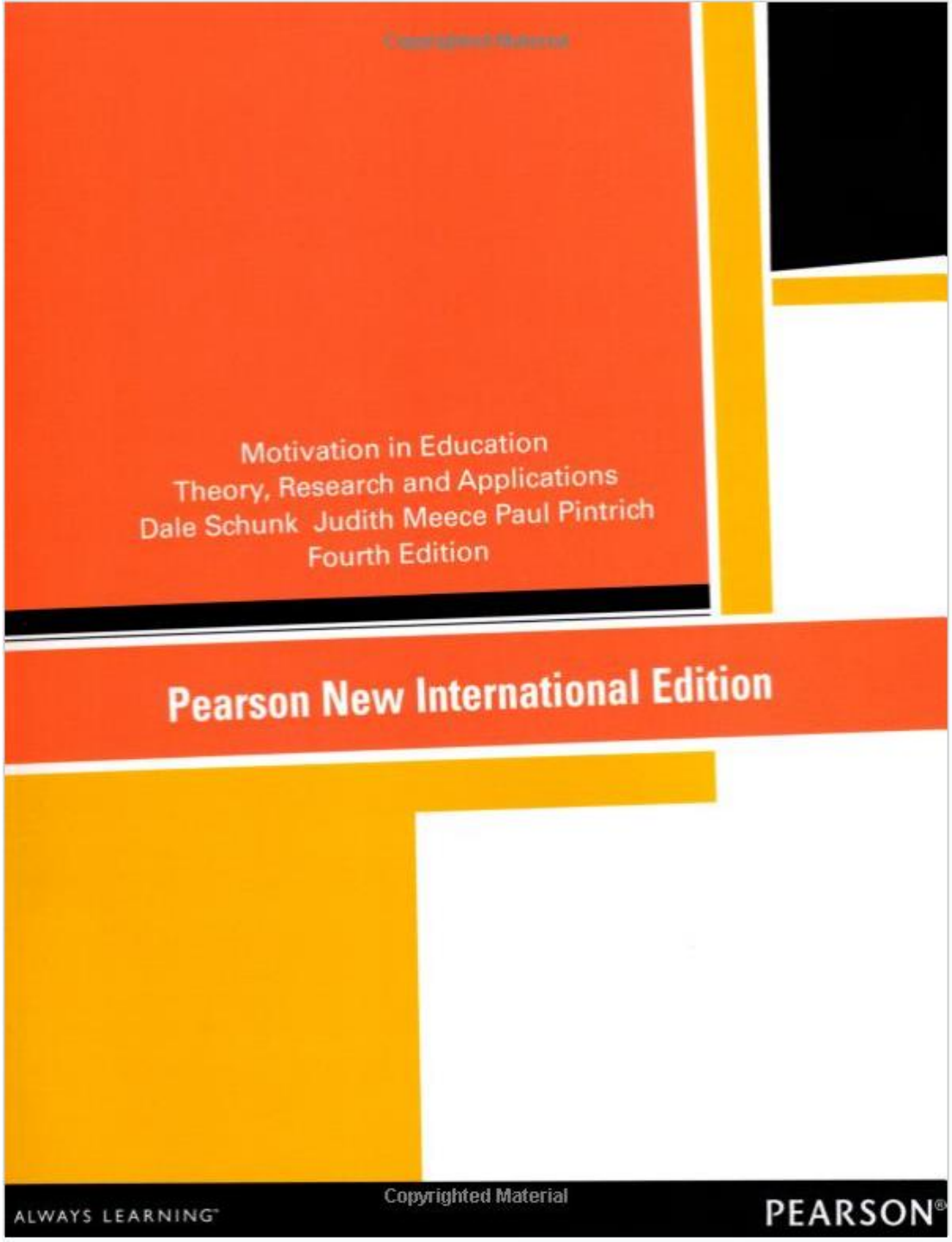
AERA, APA, & NCME (1999). *Standards for educational and psychological testing*. Washington, DC: American Educational Research Association.

Hoffman, B., & Seidel, K. (2015). Measuring teacher beliefs: For what purpose? In H. Fives & M. G. Gill (Eds.), *The international handbook of research on teachers' beliefs* (pp. 106–127). New York, NY: Routledge.

For more information on measurement and a complete list of motivation resources for educators, students, researchers and practitioners access the book website at: www.findingmo.com

Academic Motivation Scale

Academic motivation	Academic Motivation Scale (AMS)/ Questionnaire	Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, E. F. (1992). The academic motivation scale: A measure of intrinsic, extrinsic, and amotivation in education. *Educational and Psychological Measurement*, *52*(4), 1003–1017.	Confirmatory factor analysis, test–retest correlation with other versions of the measure	With many international samples the scale measures self-regulation, intrinsic motivation, and amotivation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Dale Schunk Judith Meece Paul Pintrich
Fourth Edition
Pearson New International Edition
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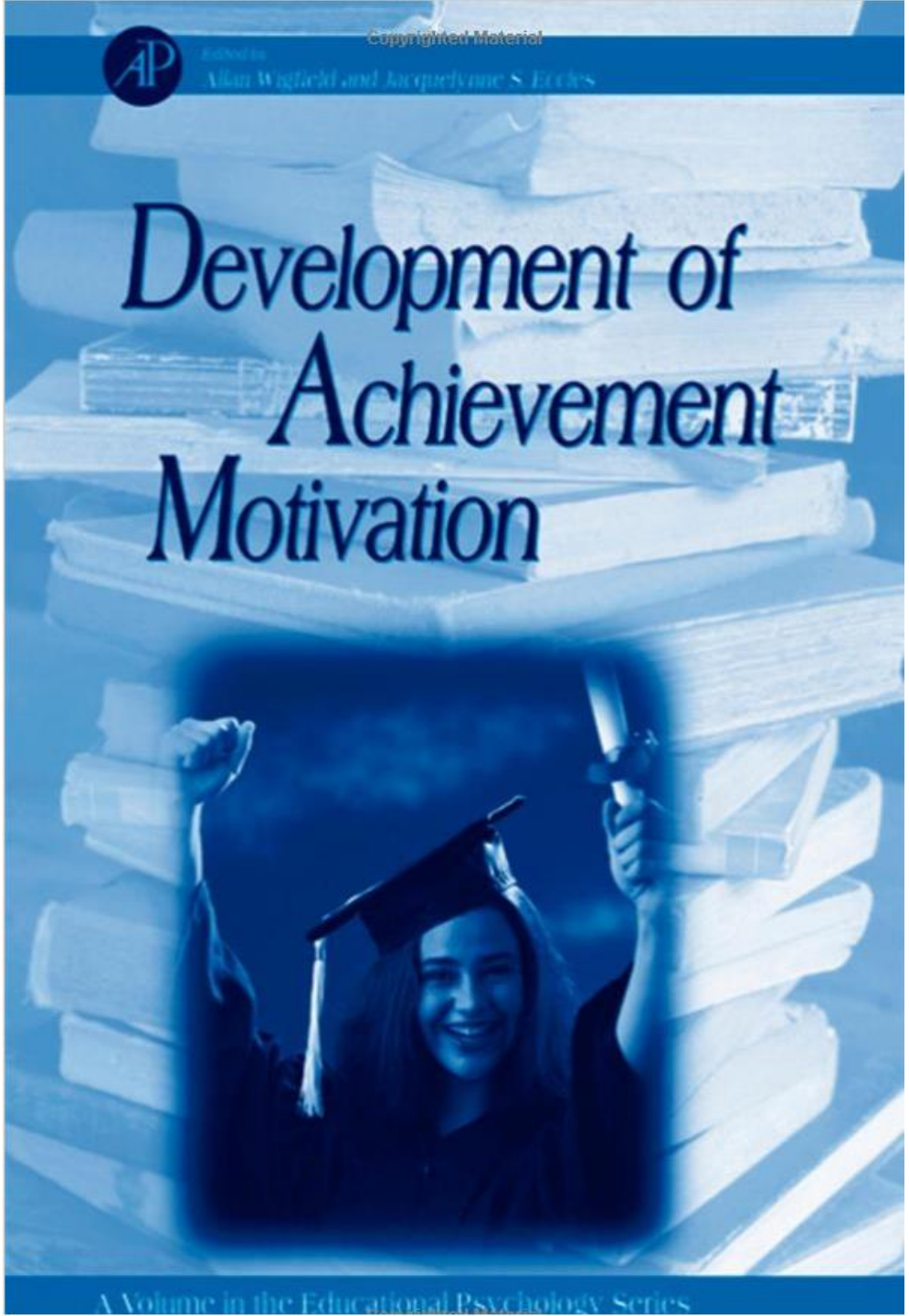
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Allan Wigfield and Jacquelynne S. Eccles
Development of Achievement Motivation
A Volume in the Educational Psychology Series

About motivation

- Motivation refers to “the reasons underlying behaviour”
- Broussard and Garrison broadly define motivation as “the attribute that moves us to do or not to do something”.
- Researchers often contrast intrinsic motivation with extrinsic motivation, which is governed by reinforcement possibilities.
- Educators believe intrinsic motivation to be more desirable and to result in better learning outcomes than extrinsic motivation.

Motivated Strategies for Learning Questionnaire MSLQ

- Prior to MSQL a lot of research on student learning focused on differences in learning styles.
- The idea of individualized learning styles became popular in the 1970s, and has greatly influenced education despite the criticism that the idea has received from some researchers.
- Theoretical background of MSQL is an adoption of a general expectancy-value model of motivation.
- First model created by Pintrich proposes three motivational components:
  - an expectancy component,
  - a value component and
  - an affective component.

Motivated Strategies for Learning Questionnaire MSLQ

- The first tool for assessing students' motivation beliefs and self-regulated learning strategies consisted of 44 questions.
- They were used to form the following five scales:
  - self-efficacy,
  - intrinsic value,
  - test anxiety,
  - cognitive strategy uses and
  - self-regulation.
- The final version of MSLQ has 81 questions divided, like the first version, into two parts:
  - motivation scales and
  - learning strategies scales.

Academic Motivation Scale AMS

- This measure of motivation towards education has been developed in French as Echelle de Motivation en Education (EME).
- The EME was composed of 28 items subdivided into seven scales.
- They assess three types of intrinsic motivation –
  - intrinsic motivation to know,
  - to accomplish things and
  - to experience stimulation,
- Three types of extrinsic motivation – external, introjected and identified regulation and amotivation.
- Some years later EME was translated into English through appropriate methodological procedures and renamed to Academic Motivation Scale

Model of Academic Motivation Inventory MUSIC®

- The MUSIC® Model of Academic Motivation Inventory (MUSIC® Inventory) is a questionnaire that can be used by instructors and researchers to assess students' perceptions of the MUSIC components for an activity or course.
- The MUSIC Inventory is a research-based questionnaire that has been shown to produce valid scores.
- The inventory was developed by Jones to measure constructs related to the five primary components of the MUSIC Model of Academic Motivation.

MUSIC® components

- **eMpowerment** shows the degree to which a student perceives that he or she has the control of his or her learning environment in the course.
- **Usefulness** illustrates the degree to which a student perceives that the coursework is useful to his or her future.
- **Success** demonstrates the degree to which the student perceives that he or she can succeed at the coursework.
- **Interest** exhibits the degree to which the student perceives that the instructional methods and coursework are interesting.
- **Caring** reveals the degree to which the student perceives that the instructor cares about whether the student succeeds in the coursework and cares about the student's well-being.

MUSIC® - literature

- Jones, B.D.: Motivating students to engage in learning: The MUSIC model of academic motivation. International Journal of Teaching and Learning in Higher Education. 21, 272–285 (2009).
- Jones, B.D.: Motivating Students by Design: Practical Strategies for Professors. CreateSpace Independent Publishing Platform (2017).
- Jones, B.D., Skaggs, G.: Measuring students' motivation: Validity evidence for the MUSIC Model of Academic Motivation Inventory. International Journal for the Scholarship of Teaching and Learning. 10, 7 (2016).
- Jones, B.D., Sigmon, M.L.: Validation Evidence for the Elementary School Version of the MUSIC® Model of Academic Motivation Inventory (Pruebas de validación para el Modelo MUSIC® de Inventario de Motivación Educativa para Escuela Primaria). Electronic Journal of Research in Educational Psychology. 14, 155–174 (2016).

Survey

- Surveys based on the MUSIC® Model of Academic Motivation Inventory took place at the end of January
- Questionnaire consisted of two parts –
  - first with 26 questions where answers were based on six-point Likert scale and second with open-ended questions.
  - First one was filled by 166 students out of 196 participating in the course (85%), second by 112 out of 196 (57%).
  - Difference in numbers of answers is perhaps caused by the fact that the second questionnaire was more time consuming and required not only clicking but also typing.

Oceń poszczególne stwierdzenia używając poniższej skali
[Please rate the items in this section using the following scale:]

1 Absolutnie nie zgadzam się [Strongly disagree]
2 Nie zgadzam się [Disagree]
3 Trochę nie zgadzam się [Somewhat disagree]
4 Trochę zgadzam się [Somewhat agree]
5 Zgadzam się [Agree]
6 W pełni się zgadzam [Strongly agree]

Termin coursework czyli aktywności kursu (czyli zajęcia ale rozumiane szerzej niż tylko wykłady i ćwiczenia!) odnosi się do wszystkiego co robisz w ramach kursu włączając w to zadania, aktywności, lektury.
[Note that the word "coursework" refers to anything that you did in the course, including assignments, activities, readings.]

*Required

1 Aktywności w kursie przykuły moją uwagę *

The coursework held my attention

	1	2	3	4	5	6	
Absolutnie nie zgadzam się	○	○	○	○	○	○	W pełni się zgadzam

Empowerment

- Five items measured empowerment
  1. I had the opportunity to decide for myself how to meet the course goals;
  2. I had the freedom to complete the coursework my own way;
  3. I had options in how to achieve the goals of the course;
  4. I had control over how I learned the course content;
  5. I had flexibility in what I was allowed to do in this course.

Usefulness

- Five items measured usefulness
  1. In general, the coursework was useful to me;
  2. The coursework was beneficial to me;
  3. I found the coursework to be relevant to my future;
  4. I will be able to use the knowledge I gained in this course;
  5. The knowledge I gained in this course is important for my future.

Success

- Four items measured success
  1. I was confident that I could succeed in the coursework;
  2. I felt that I could be successful in meeting the academic challenges in this course;
  3. I was capable of getting a high grade in this course;
  4. Throughout the course, I felt that I could be successful on the coursework)

Interest

- Six items measured interest
  1. The coursework held my attention;
  2. The instructional methods used in this course held my attention;
  3. I enjoyed the instructional methods used in this course;
  4. The instructional methods engaged me in the course;
  5. I enjoyed completing the coursework;
  6. The coursework was interesting to me.

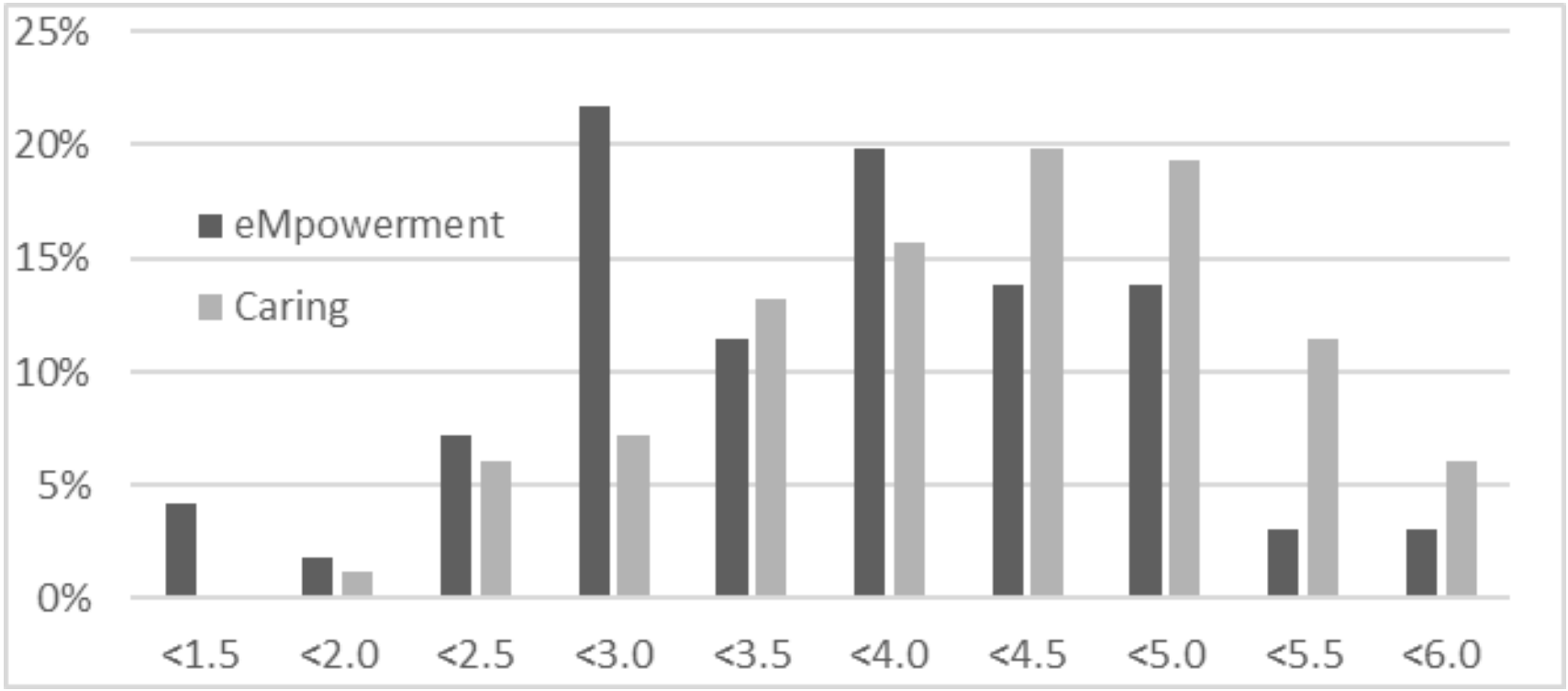
Caring

- Six items measured caring
  1. The instructor was available to answer my questions about the coursework;
  2. The instructor was willing to assist me if I needed help in the course;
  3. The instructor cared about how well I did in this course;
  4. The instructor was respectful of me;
  5. The instructor was friendly;
  6. I believe that the instructor cared about my feelings.

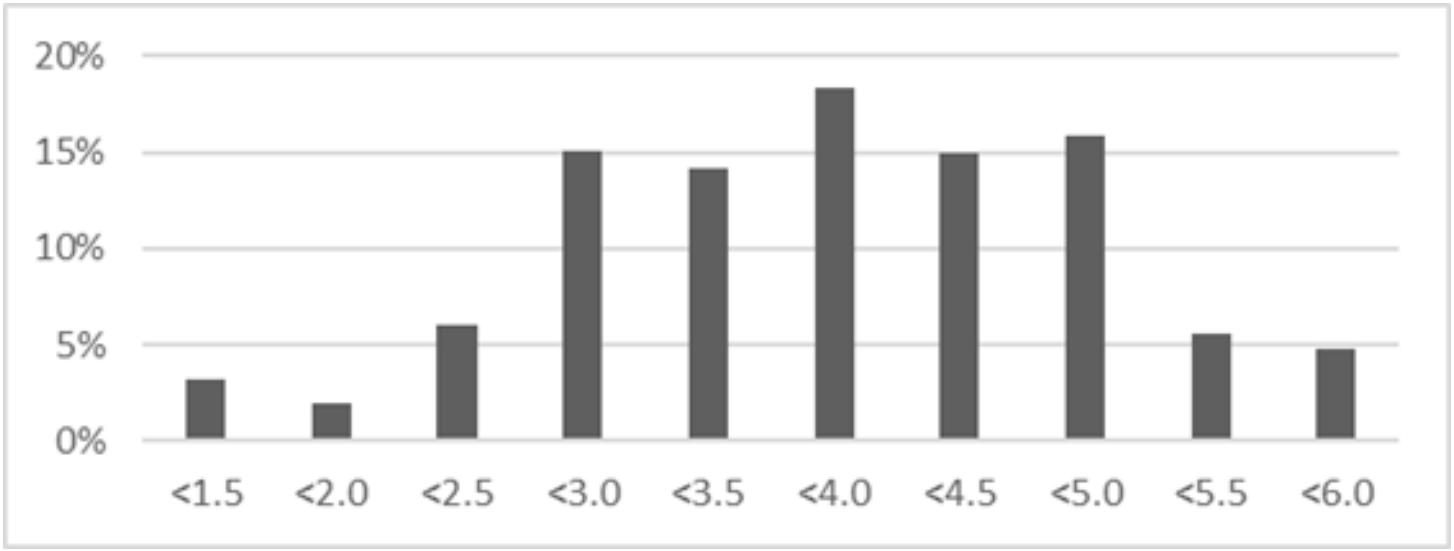
Means, standard deviations and Cronbach coefficients

Component	Mean	Std.Dev.	Cronbach
Empowerment	3.598	1.249	0.879
Usefulness	4.163	1.214	0.908
Success	3.526	1.272	0.897
Interest	3.667	1.194	0.869
Caring	4.167	1.268	0.821

Comparison of Empowerment and Caring



Central Tendency Bias



Usefulness versus Interest

Component	Mean
Empowerment	3.598
Usefulness	4.163
Success	3.526
Interest	3.667
Caring	4.167

Open-ended questions

Component	Question
Empowerment	What could be changed in this course to make you feel you had more choices in the course?
Empowerment	Which aspects of this course give you control over this course?
Usefulness	What could be changed in this course to make it more useful to you?
Success	What could be changed in this course to help you feel you could be more successful in it?
Interest	What could be changed in this course to make it more interesting and enjoyable?

What could be changed?

Response	% Overall Responses
Lack of answer	29%
Nothing	18%
I do not know	14%
Assessment methods	6%
Lectures and test	5%
More practice	5%
Other responses	23%

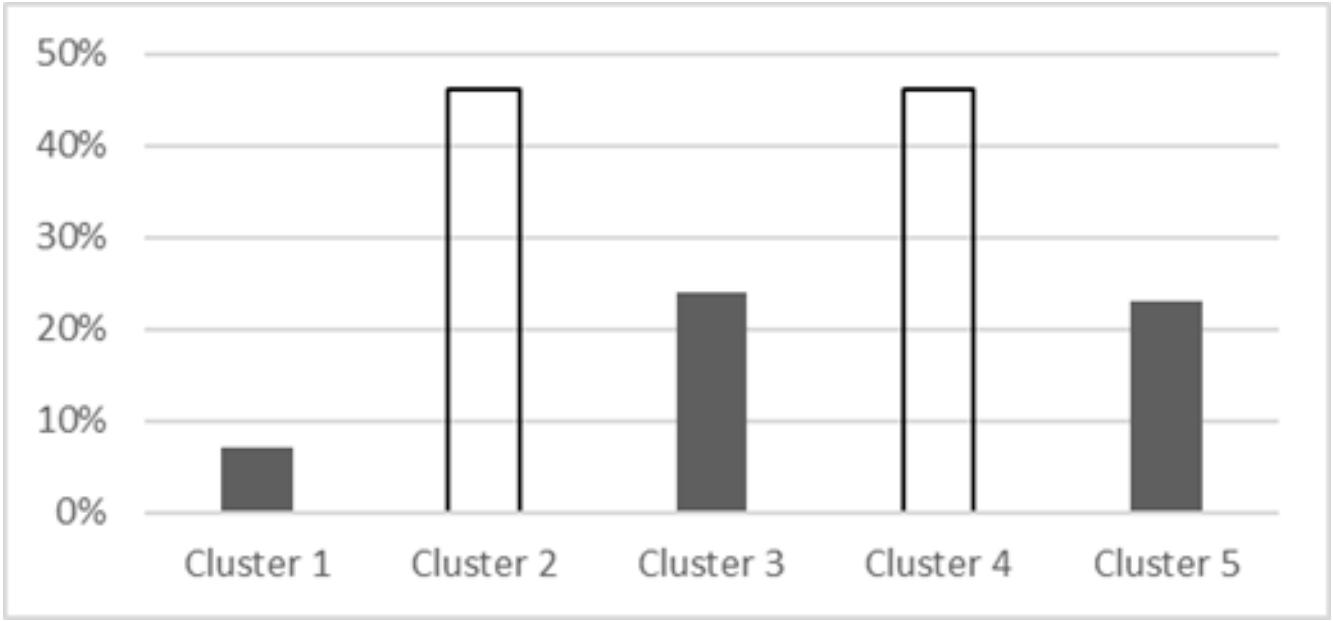
Preliminary Cluster Analysis

- The purpose of cluster analysis is to maximize within-cluster homogeneity and between-cluster heterogeneity.
- In order to define the cluster profiles, the cluster centers were first organized into six categories that described the students' reported perceptions, per the 6-point scale
  - very low (1.0 to 1.499),
  - low (1.5 to 2.499),
  - somewhat low (2.5 to 3.499),
  - somewhat high (3.5 to 4.499),
  - high (4.5 to 5.499), and
  - very high (5.5 to 6.0).

Preliminary Cluster Analysis

- Using the very low to very high categories to explain each variable's cluster center within the overall cluster membership, initial characterization of the five clusters was as follows:
  - Cluster 1 - low motivation;
  - Cluster 3 - somewhat high motivation;
  - Cluster 5 - high motivation.
- Two remaining clusters namely Cluster 2 and Cluster 4 are not yet fully identified.
- This is a subject of ongoing research.

Clusters – preliminary structure



Final remarks

- Outcomes of the first pilot MUSIC Inventory survey show big difference in results for empowerment and caring and for interest and usefulness.
- Answers to the open-ended questions were the most valuable part of the survey.
- Knowledge about students' motivation will help to design courses that engage students in learning.
- It also leads to the next question.
  - Is it possible to increase students' interest and if yes how to do that?

Faculty of Civil Engineering

Thank you for your attention

Motivation
Towards Learning
Computational Thinking:
Tertiary Education Case Study