

Qualitative Research in Computer Science Education

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ABSTRACT

This paper discusses the suitability of the qualitative research approach to computer science education research. It is based on the following two observations: First, only a small proportion of works presented in the computer science education literature contain some experimental component (Fincher and Petre, 2004; Valentine, 2004). Second, those research works conducted in computer science education that do, usually employ a quantitative research approach. This paper focuses on the qualitative research approach presenting its nature, discussing its relationships to the quantitative research approach and addressing its application in general and in the context of computer science education in particular.

Categories and Subject Descriptors

K.3.0 [Computers and Education]: K.3.0 General

General Terms

Human Factors.

Keywords

Computer science education research, Research methods, Qualitative research, Qualitative research in computer science education.

1. INTRODUCTION

Consider the following two research works conducted in order to reveal students' problem-solving strategies in the context of sort algorithms.

The results of the first research are based on a validated test on sort algorithms and an adequate quantitative data analysis method that compared the performance of students who implemented the algorithms in some programming language with that of students who did not implement the algorithms and were exposed only to the relevant theoretical aspects. This research indicates several significant differences in problem-solving performance between students of the two groups. The research is based on a representative sample and claims for conclusions.

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The second research presents data obtained from interviews with a small number of students from the two above-mentioned groups, together with its analysis. The results suggest mental processes that may explain how students of the two groups use different sort algorithms. Without any claim for the generalization of its results, the research proposes that its findings can be useful for instructors who teach sort algorithms.

It is clear that these two researches employ different research methods. We propose that the differences depend largely on the objective of the research works in general and on the way in which the research results are intended to be used in particular. On the one hand, if a researcher wishes to know whether algorithm implementation in some programming language influences students' performance of specific tasks that deal with sort algorithms, the qualitative-oriented conclusion about significant difference in students' performance may be of interest to the researcher. On the other hand, if the researcher's objective is to learn about mental processes that presumably guide students of the two groups in a variety of problem-solving situations, the researcher might find the descriptive, interview-based qualitative approach more useful.

This paper focuses on the qualitative research approach which was represented by the second research mentioned above. In a more general perspective, the paper aims at addressing the theme of research in computer science education (CSE), which has recently been receiving a lot of attention from the CSE community (Dale, 2002; Almstrum, Hazzan and Gimat, 2004; Valentine, 2004; Fincher and Petre, 2004; Almstrum, Gaudial, Hazzan and Petre, 2005). Two examples of recently conducted activities that indicate this growing interest are the new SIGCSE committee (under the SIGCSE Committee Initiative) on Teaching Computer Science Research Methods (facilitated by Hilary Holt and Anne Applin) and the Scaffolding Research in Computer Science Education hands-on workshop¹, which aims at introducing higher-education faculty to research in CSE. Participation in Scaffolding involves attending workshops as well as carrying out a research. Our own interest in the application of qualitative research in CSE stems also from our observation that most of the research conducted in CSE employs quantitative research approach. This observation is based on the review of the research articles published in the CSE literature during the past five years.

Joining the growing interest in CSE research and in light of the relative lack of qualitative research in CSE, we aim, in this article, to illustrate how the qualitative research approach, which has been

¹ The Scaffolding Research in Computer Science Education workshop: <http://depts.washington.edu/srcew/>.

Computer Science Education Research

Lei Shi



Computer Science Education Research:

Computer Science Education Research Sally Fincher, Marian Petre, 2005-09-26 This book provides an overview of how to approach computer science education research from a pragmatic perspective It represents the diversity of traditions and approaches inherent in this interdisciplinary area while also providing a structure within which to make sense of that diversity It provides multiple entry points to literature to me [The Cambridge Handbook of Computing Education Research](#)

Sally A. Fincher, Anthony V. Robins, 2019-02-21 This Handbook describes the extent and shape of computing education research today Over fifty leading researchers from academia and industry including Google and Microsoft have contributed chapters that together define and expand the evidence base The foundational chapters set the field in context articulate expertise from key disciplines and form a practical guide for new researchers They address what can be learned empirically methodologically and theoretically from each area The topic chapters explore issues that are of current interest why they matter and what is already known They include discussion of motivational context implications for practice and open questions which might suggest future research The authors provide an authoritative introduction to the field which is essential reading for policy makers as well as both new and established researchers **Computer Science Education** Sue Sentance, Erik Barendsen, Nicol R. Howard, Carsten Schulte, 2023-02-23 Drawing together the most up to date research from experts all across the world the second edition of Computer Science Education offers the most up to date coverage available on this developing subject ideal for building confidence of new pre service and in service educators teaching a new discipline It provides an international overview of key concepts pedagogical approaches and assessment practices Highlights of the second edition include New sections on machine learning and data driven epistemic programming A new focus on equity and inclusion in computer science education Chapters updated throughout including a revised chapter on relating ethical and societal aspects to knowledge rich aspects of computer science education A new set of chapters on the learning of programming including design pedagogy and misconceptions A chapter on the way we use language in the computer science classroom The book is structured to support the reader with chapter outlines synopses and key points Explanations of key concepts real life examples and reflective points keep the theory grounded in classroom practice The book is accompanied by a companion website including online summaries for each chapter 3 minute video summaries by each author and an archived chapter on taxonomies and competencies from the first edition **Learner-Centered Design of Computing Education** Mark Guzdial, 2022-05-31 Computing education is in enormous demand Many students both children and adult are realizing that they will need programming in the future This book presents the argument that they are not all going to use programming in the same way and for the same purposes What do we mean when we talk about teaching everyone to program When we target a broad audience should we have the same goals as computer science education for professional software developers How do we design computing education that works for everyone This book proposes use of a learner

centered design approach to create computing education for a broad audience. It considers several reasons for teaching computing to everyone and how the different reasons lead to different choices about learning goals and teaching methods. The book reviews the history of the idea that programming isn't just for the professional software developer. It uses research studies on teaching computing in liberal arts programs to graphic designers to high school teachers in order to explore the idea that computer science for everyone requires us to re-think how we teach and what we teach. The conclusion describes how we might create computing education for everyone.

Handbook of Research on Equity in Computer Science in P-16 Education Keengwe, Jared, Tran, Yune, 2020-11-13. The growing trend for high quality computer science in school curricula has drawn recent attention in classrooms. With an increasingly information based and global society computer science education coupled with computational thinking has become an integral part of an experience for all students given that these foundational concepts and skills intersect cross disciplinarily with a set of mental competencies that are relevant in their daily lives and work. While many agree that these concepts should be taught in schools there are systematic inequities that exist to prevent students from accessing related computer science skills. The Handbook of Research on Equity in Computer Science in P 16 Education is a comprehensive reference book that highlights relevant issues perspectives and challenges in P 16 environments that relate to the inequities that students face in accessing computer science or computational thinking and examines methods for challenging these inequities in hopes of allowing all students equal opportunities for learning these skills. Additionally it explores the challenges and policies that are created to limit access and thus reinforce systems of power and privilege. The chapters highlight issues perspectives and challenges faced in P 16 environments that include gender and racial imbalances population of growing computer science teachers who are predominantly white and male teacher preparation or lack of faculty expertise professional development programs and more. It is intended for teacher educators K 12 teachers high school counselors college faculty in the computer science department school administrators curriculum and instructional designers directors of teaching and learning centers policymakers researchers and students.

Handbook of Research on Integrating Computer Science and Computational Thinking in K-12 Education Keengwe, Jared, Wachira, Patrick, 2019-12-13. As technology continues to develop and prove its importance in modern society certain professions are acclimating. Aspects such as computer science and computational thinking are becoming essential areas of study. Implementing these subject areas into teaching practices is necessary for younger generations to adapt to the developing world. There is a critical need to examine the pedagogical implications of these technological skills and implement them into the global curriculum. The Handbook of Research on Integrating Computer Science and Computational Thinking in K 12 Education is a collection of innovative research on the methods and applications of computer science curriculum development within primary and secondary education. While highlighting topics including pedagogical implications comprehensive techniques and teacher preparation models this book is ideally designed

for teachers IT consultants curriculum developers instructional designers educational software developers higher education faculty administrators policymakers researchers and graduate students *Past, Present and Future of Computing Education Research* Mikko Apiola, Sonsoles López-Pernas, Mohammed Saqr, 2023-04-17 This book presents a collection of meta studies reviews and scientometric analyses that together reveal a fresh picture about the past present and future of computing education research CER as a field of science The book begins with three chapters that discuss and summarise meta research about the foundations of CER its disciplinary identity and use of research methodologies and theories Based on this the book proceeds with several scientometric analyses which explore authors and their collaboration networks dissemination practices international collaboration and shifts in research focus over the years Analyses of dissemination are deepened in two chapters that focus on some of the most influential publication venues of CER The book also contains a series of country or region level analyses including chapters that focus on the evolution of CER in the Baltic Region Finland Australasia Israel and in the UK Ireland Two chapters present case studies of influential CER initiatives in Sweden and Namibia This book also includes chapters that focus on CER conducted at school level and cover crucially important issues such as technology ethics algorithmic bias and their implications for CER In all this book contributes to building an understanding of the past present and future of CER This book also contributes new practical guidelines highlights topical areas of research shows who to connect with where to publish and gives ideas of innovative research niches The book takes a unique methodological approach by presenting a combination of meta studies scientometric analyses of publication metadata and large scale studies about the evolution of CER in different geographical regions This book is intended for educational practitioners researchers students and anyone interested in CER This book was written in collaboration with some of the leading experts of the field

Proceedings of Second Computer Science Education Research Conference Association for Computing Machinery, ACM Digital Library, 2012 *Computer Science in K-12* Shuchi Grover, 2020-05 Coding teaches our students the essence of logical thinking and problem solving while also preparing them for a world in which computing is becoming increasingly pervasive While there s excitement and enthusiasm about programming becoming an intrinsic part of K 12 curricula the world over there s also growing anxiety about preparing teachers to teach effectively at all grade levels This book strives to be an essential enduring practical guide for every K 12 teacher anywhere who is either teaching or planning to teach computer science and programming at any grade level To this end readers will discover An A to Z organization that affords comprehensive insight into teaching introductory programming 26 chapters that cover foundational concepts practices and well researched pedagogies related to teaching introductory programming as an integral part of K 12 computer science Cumulatively these chapters address the two salient building blocks of effective teaching of introductory programming what content to teach concepts and practices and how to teach pedagogy Concrete ideas and rich grade appropriate examples inspired by practice and research for classroom use Perspectives and experiences shared by educators

and scholars who are actively practicing and or examining the teaching of computer science and programming in K 12 classrooms

Guide to Teaching Computer Science Orit Hazzan, Noa Ragonis, Tami Lapidot, 2026-01-29 This concise yet thorough textbook presents an active learning model for the teaching of computer science Offering both a conceptual framework and detailed implementation guidelines the work is designed to support a Methods of Teaching Computer Science MTCS course but may be applied to the teaching of any area of computer science at any level from elementary school to university This text is not limited to any specific curriculum or programming language but instead suggests various options for lesson and syllabus organization Fully updated and revised the third edition features more than 40 new activities bringing the total to more than 150 together with new chapters on computational thinking data science and soft concepts and soft skills This edition also introduces new conceptual frameworks for teaching such as the MERge model and new formats for the professional development of computer science educators Topics and features includes an extensive set of activities to further support the pedagogical principles outlined in each chapter discusses educational approaches to computational thinking how to address soft concepts and skills in a MTCS course and the pedagogy of data science NEW focuses on teaching methods lab based teaching and research in computer science education as well as on problem solving strategies examines how to recognize and address learners misconceptions and the different types of questions teachers can use to vary their teaching methods provides coverage of assessment teaching planning and designing a MTCS course reviews high school teacher preparation programs and how prospective teachers can gain experience in teaching computer science This easy to follow textbook and teaching guide will prove invaluable to computer science educators within all frameworks including university instructors and high school teachers as well as to instructors of computer science teacher preparation programs

Navigating Computer Science Education in the 21st Century Bosch, Chantelle, Goosen, Leila, Chetty, Jacqui, 2024-02-26 Students often face challenges in a swiftly advancing Computer Science Education CSE where technologies evolve rapidly and concepts unfold with overwhelming intricacies As society becomes interwoven with technology how essential is the integration of CSE into the educational framework to adequately equip future generations for the complexities of the digital era Navigating Computer Science Education in the 21st Century advocates integrating CSE into curricula underlining its crucial role in early childhood development The book grapples with the challenge of introducing children to technology responsibly addressing concerns about unmonitored screen time while emphasizing the necessity of evidence based approaches for educators Within these pages effective teaching strategies are linked to successes in CSE The book explores learner centered teaching methodologies in computer science emphasizing individualized instruction active learning and collaborative approaches It evaluates the effectiveness of traditional lecture based teaching against more innovative strategies such as game based learning and collaborative approaches By presenting studies that delve into the impact of these strategies on student engagement and motivation the book equips educators with the insights needed to

make informed decisions tailored to diverse learning environments

New Directions for Computing Education Samuel B. Fee, Amanda M. Holland-Minkley, Thomas E. Lombardi, 2017-04-17 Why should every student take a computing course What should be the content of these courses How should they be taught and by whom This book addresses these questions by identifying the broader reaches of computing education problem solving and critical thinking as a general approach to learning The book discusses new approaches to computing education and considers whether the modern ubiquity of computing requires an educational approach that is inherently interdisciplinary and distinct from the traditional computer science perspective The alternative approach that the authors advocate derives its mission from an intent to embed itself within an interdisciplinary arts and science context An interdisciplinary approach to computing is compellingly valuable for students and educational institutions alike Its goal is to support the educational and intellectual needs of students with interests in the entire range of academic disciplines It capitalizes on students focus on career development and employers demand for technical while also engaging a diverse student body that may not possess a pre existing interest in computing for computing s sake This approach makes directly evident the applicability of computer science topics to real world interdisciplinary problems beyond computing and recognizes that technical and computational abilities are essential within every discipline The book offers a valuable resource for computer science and computing education instructors who are presently re thinking their curricula and pedagogical approaches and are actively trying new methods in the classroom It will also benefit graduate students considering a future of teaching in the field as well as administrators in both higher education and high schools interested in becoming conversant in the discourse surrounding the future of computing education

Handbook of Research on Tools for Teaching Computational Thinking in P-12 Education Kalogiannakis, Michail, Papadakis, Stamatios, 2020-06-26 While the growth of computational thinking has brought new awareness to the importance of computing education it has also created new challenges Many educational initiatives focus solely on the programming aspects such as variables loops conditionals parallelism operators and data handling divorcing computing from real world contexts and applications This decontextualization threatens to make learners believe that they do not need to learn computing as they cannot envision a future in which they will need to use it just as many see math and physics education as unnecessary The Handbook of Research on Tools for Teaching Computational Thinking in P 12 Education is a cutting edge research publication that examines the implementation of computational thinking into school curriculum in order to develop creative problem solving skills and to build a computational identity which will allow for future STEM growth Moreover the book advocates for a new approach to computing education that argues that while learning about computing young people should also have opportunities to create with computing which will have a direct impact on their lives and their communities Featuring a wide range of topics such as assessment digital teaching and educational robotics this book is ideal for academicians instructional designers teachers education professionals administrators researchers and

students **Professional Development for In-Service Teachers** Chrystalla Mouza, Anne Ottenbreit-Leftwich, Aman Yadav, 2022-07-19 This book provides professional development approaches for teachers to integrate computing in K-8 curricula or deliver stand-alone computer science courses at the secondary level. It identifies computational competencies, promising pedagogical strategies, and alternative pathways for ongoing learning, including microcredentials.

Effective Computer Science Education in K-12 Classrooms Kert, Serhat Bahadır, 2024-12-13 The growing influence of information technologies in everyday life has underscored the increasing importance of computer science education. The goal of computer science education is not merely to teach students how to code but to develop individuals with strong problem-solving abilities. Pedagogy-driven concepts such as computational thinking and computational participation highlight the problem-solving dimension of computer science and are shaping learning approaches worldwide. Effective instructional design is critical for environments where these concepts are taught. The proposed book, *Effective Computer Science Education in K-12 Classrooms*, aims to offer a scientific and holistic instructional roadmap for educators at the K-12 level. By detailing concrete educational approaches, this book will provide valuable insights and strategies to enhance the quality and efficiency of computer science education. It will serve as a guide for educators seeking to develop content and teaching methods that are both pedagogically sound and highly effective in building problem-solving skills among students.

Computer Science for Middle School (CS4MS): How Middle School Administrators and Teachers Implement Computer Science Curricula Verjina Mayer, 2019 Computer science education in K-12 schools is a popular topic of study, especially in quantitative research. Many findings concur that computer science education should be introduced at lower grade levels to provide students with early exposure to computing skills or computational thinking more broadly. While there is substantial research about computer science education implementation at the elementary and high school levels, however, there is a paucity of qualitative research about computer science curriculum implementation at the middle school level. The current case study concentrated on the computer science implementation stories of six teachers and six administrators at six middle schools in a large urban public school district with a large number of socioeconomically disadvantaged and traditionally underrepresented minority students. Through the theoretical framework of diffusion of innovation in organizations, the study investigated the essential elements of a computer science curriculum implementation as well as the essential elements of sustaining a computer science education implementation. The study also focused on the challenges of computer science education implementation and how the challenges, if any, varied by student population. Lastly, the study sought data on solutions to implementation challenges and how solutions, if any, varied by student population. Study findings show that when middle school teachers do not receive computer science curriculum training, their implementation of the curriculum does not reach the higher stages of diffusion, such as redefining, clarifying, and routinizing. Results also indicate that the middle school computer science teacher's dedication to and enthusiasm for teaching the subject is essential to sustaining the implementation. Furthermore, when the

administrator and teacher in charge of computer science education are both committed to the implementation then they are more likely to exhibit a problem solving mindset Challenges to implementing a middle school computer science curriculum include securing funding for training to teach the curriculum in addition to finding enthusiastic teachers to teach the topic A further challenge was the lack of teacher support from administrators who were not completely sold on any particular computer science curriculum or plan of implementation Challenges pertaining to students include teachers not having any assistance with special education students who are not necessarily ready for a computer science classroom environment Teachers also expressed challenges in terms of student behavior and students reluctance to work in teams especially when there is not enough equipment for every student Solutions to the funding challenge that worked for participants of the study included continuous fundraising and grantwriting Administrators who were more dedicated to implementing computer science education at their middle schools had all read research about the importance of early exposure to computer science opportunities as well as project based learning curricula Solutions related to special education students and others who were not ready for the advanced curriculum included having multiple levels of the work available for students to feel challenged at their level Teacher enthusiasm and ability to teach CS can be found among existing middle school teachers Administrators who are informed about middle school CS education are in a better position to make teacher centered and student centered decisions about CS implementation When administrators visions of CS implementation align with the middle school teacher s vision of CS implementation the social network that is generated by the administrator and CS teacher working collaboratively makes a CS program more sustainable The alignment of middle school CS education research with existing research about diffusion of innovations makes these insights more accessible Consequently the implementation of middle school CS education can be better understood by using the five stages of diffusion of innovations as a theoretical framework Trends in Computer Science Education Lisa Barrow,Silvana Freire,Marisa de la Torre,2020-03 *Intelligent Support for Computer Science Education* Barbara Di Eugenio,Davide Fossati,Nick Green,2021-09-22 Intelligent Support for Computer Science Education presents the authors research journey into the effectiveness of human tutoring with the goal of developing educational technology that can be used to improve introductory Computer Science education at the undergraduate level Nowadays Computer Science education is central to the concerns of society as attested by the penetration of information technology in all aspects of our lives consequently in the last few years interest in Computer Science at all levels of schooling especially at the college level has been flourishing However introductory concepts in Computer Science such as data structures and recursion are difficult for novices to grasp Key Features Includes a comprehensive and succinct overview of the Computer Science education landscape at all levels of education Provides in depth analysis of one on one human tutoring dialogues in introductory Computer Science at college level Describes a scalable plug in based Intelligent Tutoring System architecture portable to different topics and pedagogical strategies Presents systematic controlled evaluation of different

versions of the system in ecologically valid settings 18 actual classes and their laboratory sessions Provides a time series analysis of student behavior when interacting with the system This book will be of special interest to the Computer Science education community specifically instructors of introductory courses at the college level and Advanced Placement AP courses at the high school level Additionally all the authors work is relevant to the Educational Technology community especially to those working in Intelligent Tutoring Systems their interfaces and Educational Data Mining in particular as applied to human human pedagogical interactions and to user interaction with educational software **Proceedings of the 7th Computer Science Education Research Conference** Vreda Pieterse,2018 **Journal of Research on Computing in Education** ,1998

Enjoying the Track of Phrase: An Psychological Symphony within **Computer Science Education Research**

In a world eaten by screens and the ceaseless chatter of fast connection, the melodic beauty and psychological symphony created by the prepared word often diminish into the backdrop, eclipsed by the persistent sound and interruptions that permeate our lives. But, located within the pages of **Computer Science Education Research** an enchanting fictional value brimming with raw emotions, lies an immersive symphony waiting to be embraced. Constructed by an elegant musician of language, that charming masterpiece conducts viewers on a psychological journey, skillfully unraveling the concealed melodies and profound influence resonating within each cautiously constructed phrase. Within the depths with this touching assessment, we can discover the book is main harmonies, analyze its enthralling writing style, and submit ourselves to the profound resonance that echoes in the depths of readers souls.

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Computer Science Education Research Introduction

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