UNDERSTANDING THE CHALLENGES OF TEACHING COMPUTER SCIENCE SUBJECTS FROM SCHOOL TEACHERS' PERSPECTIVE

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ABSTRACT

The implementation of Computer Science (CS) in Malaysian secondary schools aims to develop digital proficiency among youths. Despite this, Kedah state has seen fluctuating enrolment in CS elective subjects for the Sijil Pelajaran Malaysia (SPM) exam between 2018 and 2021, which contrasts with the increasing popularity of CS programs in higher education and the rising demand for CS skills. Addressing the challenges teachers face in delivering CS subjects is crucial, including issues like inadequate training, limited resources, language barriers, and diverse student backgrounds. This study uses a quantitative approach with self-developed questionnaires distributed among experienced CS teachers in Kedah to identify these challenges and propose solutions. Findings reveal a mix of experienced and less experienced teachers, mostly with medium-level proficiency. The study highlights difficulties in teaching Form 4 and Form 5 content and suggests improvements through professional development, collaboration, hands-on experiences, and updated resources to enhance teaching effectiveness and better align secondary education with higher education and job market needs.

INTRODUCTION

Computer science (CS) education in Malaysia has been introduced at different levels of schooling over the years. The trajectory of CS education in Malaysia has been marked by significant milestones. In 1989, the initiation of the Computer Literacy Programme by the Ministry of Education (MOE) played a pivotal role in introducing fundamental computer skills and applications to students at both primary and secondary levels (Shahadan, 1993). This laid the foundation for digital proficiency among the younger generation. Subsequently, the landmark year of 1999 saw the launch of the Smart School Project, a visionary endeavour that aimed to revolutionize education by infusing Information and Communication Technology (ICT) into the teaching and learning processes. This encompassed equipping schools with essential technological resources such as computers, software, networks, and multimedia tools, reflecting the commitment to modernizing pedagogical approaches through digital integration.
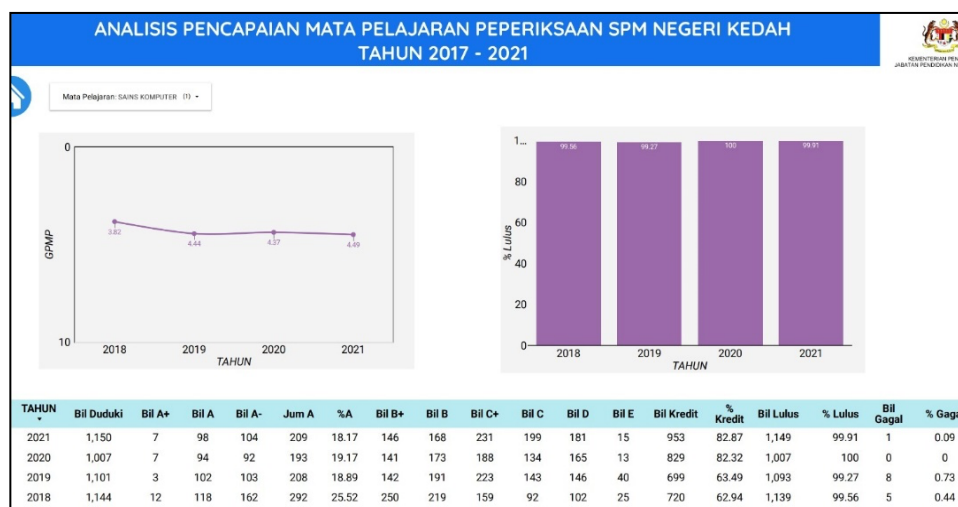
The evolution of CS education continued in 2003 when the MOE unveiled the ICT Curriculum for secondary schools (Yunus & Sulaiman, 2014). This comprehensive curriculum encompassed an array of subjects including computer systems, programming, multimedia, and internet studies. A significant revision in 2010 enriched the curriculum by introducing advanced topics like database management, networking, and cybersecurity. In line with the ever-changing technological landscape, these updates ensured students were equipped with contemporary and relevant knowledge. A notable progression emerged in 2017 with the implementation of the Computational Thinking and Computer Science (CTCS) Module at primary schools (Ong et al., 2023). This module fostered the development of logical thinking, problem-solving skills, and creativity in students through coding activities, seamlessly integrated into subjects like Mathematics, Science, and Design and Technology. Lastly, in 2019, the MOE announced a forward-looking initiative, Coding@Schools, that envisions coding as a mandatory subject for students from Year 4 to Form 5 by 2024. This ambitious program not only underscores the growing importance of coding skills in the digital age but also underscores the commitment to preparing students for future challenges through structured training, well-defined curricula, and comprehensive support mechanisms.

Certainly, the landscape of CS education in Malaysia has undergone transformation to align with the dynamic demands and opportunities presented by the digital age. However, a divergent scenario is evident in Kedah, where the enrolment trend for CS as an elective subject for the Sijil Pelajaran Malaysia (SPM) examination has shown inconsistency from 2018 to 2021 as depicted in Figure 1.

In 2018, the enrolment count stood at 1144 students, followed by a decline in both 2019 and 2020, registering enrolments of 1001 and 1007 respectively. Notably, a slight resurgence was observed in 2021 with 1150 students opting for the subject. This fluctuating pattern has raised concerns within the Kedah State Education Department (JPN), as it contrasts starkly with the prevailing higher education landscape, where computer science programs are steadily gaining popularity. Besides, the modern job market prominently showcases positions centred around computer science expertise.

ANALISIS PENCAPAIAN MATA PELAJARAN PEPERIKSAAN SPM NEGERI KEDAH
TAHUN 2017 - 2021

Mata Pelajaran: SAINS KOMPUTER (1) ▾

TAHUN	Bil Duduki	Bil A+	Bil A	Bil A-	Jum A	%A	Bil B+	Bil B	Bil C+	Bil C	Bil D	Bil E	Bil Kredit	% Kredit	Bil Lulus	% Lulus	Bil Gagal	% Gagal
2021	1,150	7	98	104	209	18.17	146	168	231	199	181	15	953	82.87	1,149	99.91	1	0.09
2020	1,007	7	94	92	193	19.17	141	173	188	134	165	13	829	82.32	1,007	100	0	0
2019	1,101	3	102	103	208	18.89	142	191	223	143	146	40	699	63.49	1,093	99.27	8	0.73
2018	1,144	12	118	162	292	25.52	250	219	159	92	102	25	720	62.94	1,139	99.56	5	0.44

Therefore, to cultivate student interest in pursuing CS, it's essential to address the issue at its core. This involves identifying and assisting teachers in presenting the subject in more captivating and engaging ways. By leveraging this approach, the downward trend in CS enrolment for SPM can be reversed, fostering a renewed enthusiasm for this vital subject among Kedah's youth.

Considering extensive consultations with educational authorities within the Kedah State Education Department (JPN Kedah), a significant and alarming trend has come to the forefront. This trend involves a gradual decline in the enrolment figures for CS subject, coinciding with a simultaneous rise in the rates of student failure. Difficulties in teaching this subject where teachers struggle to create a balance between its complexity and students' comprehension are among the issue that may contribute to the issues (Carter & Boyle, 2002). Moreover, the struggling in delivering CS subjects typically results from the use of ineffective teaching strategies, which may fail to adequately express complex concepts and impede students' comprehension and participation (Cheah, 2020). Furthermore, to create effective teaching strategies, teachers require good delivery skills to effectively convey all the concepts to the students (Sentence & Csizmadia, 2017).

The primary focus of this research centres on the formidable challenges educators face in teaching the subject in question. By conducting in-depth interviews with seasoned educators and distributing surveys among both instructors, the study aims to unearth a deeper comprehension of these challenges. These challenges encompass multiple dimensions, spanning pedagogical methodologies, curriculum structuring, and the availability of necessary resources. Addressing these challenges necessitates interventions that cater to specialized training requirements, the creation of student-centric learning materials, and the optimization of classroom resources for more interactive and engaging educational experiences. In essence, this study underscores the pressing need for strategic interventions that can rejuvenate the subject's instructional framework, mitigate declining enrolment and elevated failure rates, and steer it towards a trajectory of renewed scholastic accomplishment.
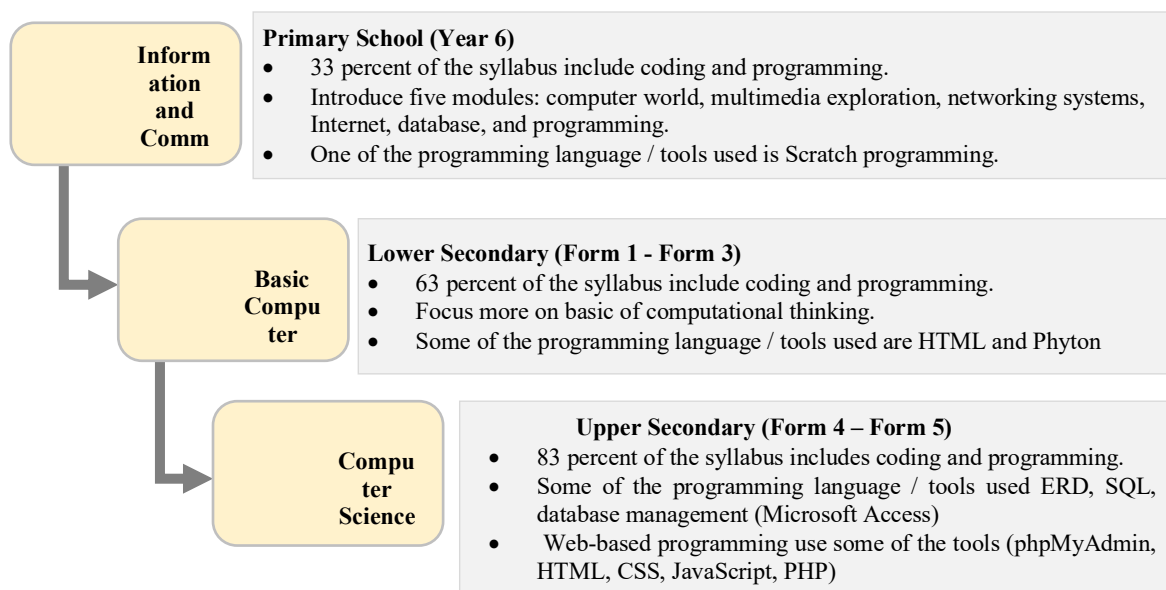
In the development of the Malaysian Education Development Plan (PPPM) 2013-2025, the Science, Technology, Engineering, and Mathematics (STEM) package is one of the crucial agenda in education aiming to increase expertise manpower in the research and digital industry in Malaysia (Jamaluddin et al., 2023, Adam & Halim, 2019). In the context of education, STEM focuses on cultivating students in science, technology, engineering, and mathematics fields (Malaysia & Pendidikan, 2016).

In 2016, relevant to Education 4.0, the Ministry of Education Malaysia took the initiative to introduce ICT subject for year six primary school students. This is to introduce students to CS prior to secondary-level CS subjects. In January 2017, the Secondary School Standards-Based Curriculum (KSSM) was introduced which replaced the Integrated Curriculum for Secondary Schools (KBSM) and aligned with PPPM. The focus is to develop critical, creative, and innovative thinking, problem-solving, and leadership skills allowing students to compete globally.

These changes applied to ten elective subjects in *Mata Pelajaran Elektif Ikhtisas* (MPEI) in the STEM package. The lower secondary level offers Basic Computer Science subjects. It educates students on computational thinking preparing them with fundamental CS knowledge. In the upper secondary level, students have the option to register the CS, Invention or Engineering, or Vocational-related subjects as their elective subjects. Figure 2 shows the subjects structure starts with Information and Communication (ICT) for year six primary schools' students giving the spotlight on understanding computer world, multimedia exploration, networking systems, Internet, database, and programming. Students can further study CS in Basic Computer Science (lower secondary) and Computer Science (upper secondary) subjects in the secondary schools (Mohamed Salleh et al., 2021).

Figure 2

Computer Science subject structure.

Information and Comm	**Primary School (Year 6)** • 33 percent of the syllabus include coding and programming. • Introduce five modules: computer world, multimedia exploration, networking systems, Internet, database, and programming. • One of the programming language / tools used is Scratch programming.
Basic Computer	**Lower Secondary (Form 1 - Form 3)** • 63 percent of the syllabus include coding and programming. • Focus more on basic of computational thinking. • Some of the programming language / tools used are HTML and Phyton
Computer Science	**Upper Secondary (Form 4 – Form 5)** • 83 percent of the syllabus includes coding and programming. • Some of the programming language / tools used ERD, SQL, database management (Microsoft Access) • Web-based programming use some of the tools (phpMyAdmin, HTML, CSS, JavaScript, PHP)

Basic Computer Science and Computer Science subjects require qualified teachers in teaching database and programming subjects. The lower secondary which is the Basic Computer Science subject is more on the basics of computational thinking and only focuses on 63% of coding and programming. While continuing in the upper secondary students are exposed to 84% of coding and programming in the CS subject. In database topics, teachers need to have skills in Entity Relationship Diagrams (ERD), Structured Query Language (SQL), and database management systems such as using Microsoft Access. In programming topics, skills in Web Programming using PHP, phpMyAdmin, HTML, CSS and JavaScript is compulsory. Thus, programming is important in developing students' interest in STEM.

Nevertheless, teaching computer science subjects is challenging due to varieties of factors such as limited resources, language barriers, diverse student backgrounds, teacher training, infrastructure disparities, and lack of qualified teachers (Mohamed Salleh et al., 2021).

With the need of workforce in research and digital industries, there are high demand for CS expertise. Alongside, teachers play a crucial role in delivering knowledge to students (Adam & Halim, 2019), hence, hold the responsibility of educating students with relevant skills and keeping students up to date with the latest technology (Muniandy et al., 2022).

The roles of CS teachers in secondary schools are content delivery, skills development, promoting critical thinking, and fostering interest in the students. Teachers need to be able to teach and creatively stimulate student interest in the STEM subjects (Ramli & Talib, 2017). They need to master and have in-depth knowledge of CS prior delivering the knowledge to students (Puganesri & Saifullizam, 2019).

However, these roles have become challenges for some teachers. Among the factors are lack of qualified teachers in CS, resource constraints, and limited training for teachers. Ramli and Talib (2017) mentioned that the decrease teachers' motivation can be a result of stress out to teachers. Therefore, understanding the difficulties of teaching CS subjects from teachers' perspectives is important to be considered.

Researchers have identified the insufficient of qualified teachers in teaching CS in secondary schools in Malaysia and many educational systems around the world. In research by Saari & Hopkins, (2020), some of the teachers do not have the theoretical knowledge and are not motivated to learn programming.

In a recent survey, (Puganesri & Saifullizam, 2019) investigated CS education in Malaysia's schools focussing on teaching and learning CS in achieving Education 4.0 objective. The results showed that some of the teachers' background are not from CS, and only have basic knowledge on CS, thus this is a knowledge delivering challenge. Another finding was limited resources for reference and insufficient of CS training. Suitable modules, courses, seminars, or programs should be provided for CS teachers in improving their skills.

A proper guideline to enhance teachers' knowledge is compulsory as knowledge and skills is consider as an element to the achievement in teaching and learning process (Durak & Saritepeci, 2018).

In Malaysia Budget 2023, the government has allocated budgets to uplift national education system including RM38 million in improving teachers teaching and learning aids in schools (Ministry of Finance, 2023). Together, the government initiatives, educational institutions and industries as supporting entities should walk side by side in thriving Malaysia education to the highest achievement (Adam & Halim, 2019).

In view of all that has been mentioned so far, these studies provide key insights into the challenges in teaching CS in Malaysia. There is a need to provide opportunities and encouragement to CS teachers such professional training, collaboration among CS lecturers and industries, support programs and online resources. These approaches capable to reduce the challenges and motivate teachers towards the STEM achievement goals.

METHODOLOGY

The research employed quantitative methodology where a set of self-developed questionnaires was used to collect data on teachers' perceptions on teaching computer science subjects. Tailored to elicit valuable insights, the questionnaire was thoughtfully designed to delve into teachers' perceptions, identifying the challenges faced by them in teaching the subject. The questionnaire had been divided into 5 sections.

    i.   Teaching experience
    ii.   Teacher's background in teaching Computer Science subjects
    iii.   Teacher proficiency in delivering each chapter content in Form 4 Textbook
    iv.   Teacher proficiency in delivering each chapter content in Form 5 Textbook
    v.   Explore teachers' suggestion for improving the teaching of computer science lessons

The final version of the questionnaire was distributed to all experienced science computer teachers that teaches students in both form 4 and form 5 around Kedah.

The questionnaire had been distributed to all experienced science computer teachers that teaches students in both form 4 and form 5 around Kedah randomly. They were given one month to complete the questionnaire. Towards the end, 37 respondents had completed the questionnaire.
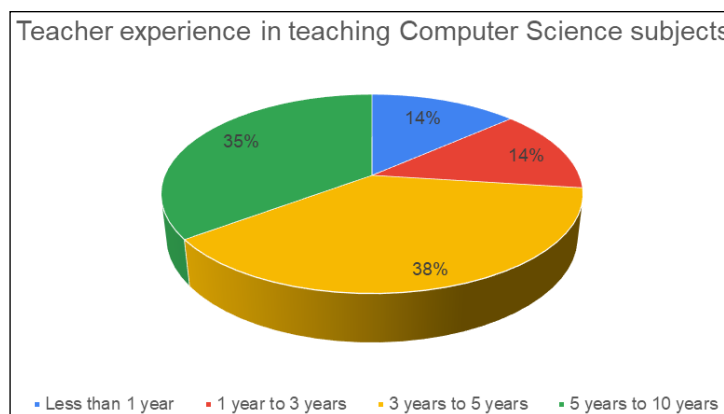
RESULTS

Teaching Experience

Figure 3 shows that the majority of the 37 respondents (35%) have 5 to 10 years of experience teaching Computer Science subjects. This is followed by 38% of respondents who have 3 to 5 years of experience, 14% with 1 to 3 years of experience, and 14% with less than 1 year of experience.

Figure 3
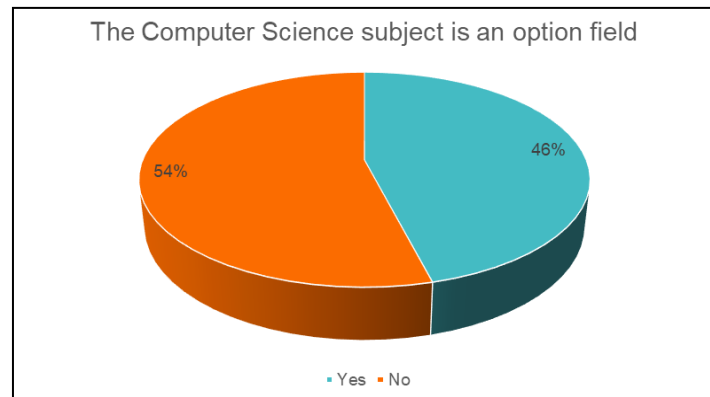
Experience in teaching Computer Science subjects.

This data suggests that there is a good mix of experienced and less experienced teachers teaching Computer Science subjects. The high percentage of teachers with 5 to 10 years of experience is encouraging, as it suggests that there is a pool of experienced teachers who can provide high-quality instruction in this subject. However, the relatively high percentage of teachers with less than 1 year of experience is also concerning, as it suggests that there may be some teachers who are not yet fully prepared to teach Computer Science.

Teacher's Background in Teaching Computer Science Subjects

Figure 4

Option field.

The Computer Science subject is an option field
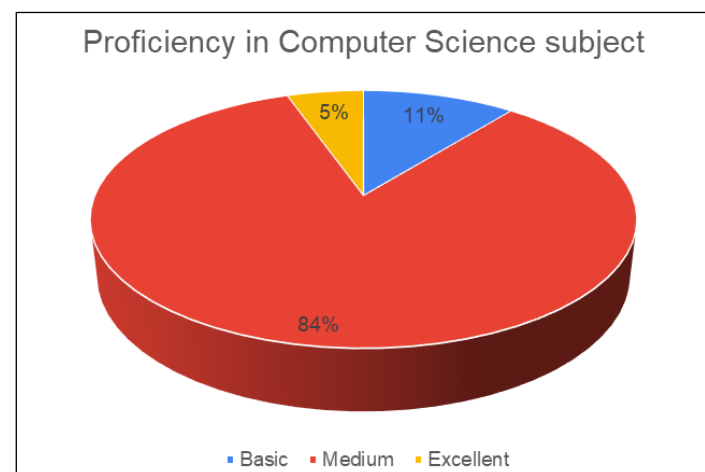
46%

54%

▪ Yes ▪ No

The data shows that 46% of the 37 respondents selected Computer Science as their option when they continued their studies at the degree level. This means that 15 respondents selected Computer Science as their option, while the remaining 22 respondents did not.

This distribution highlights that a substantial portion of the teachers pursued their education in Computer Science field, indicating their specific interest and commitment to the subject.

Figure 5

Teacher's proficiency.

Proficiency in Computer Science subject

5% 11%

84%

▪ Basic ▪ Medium ▪ Excellent

The data shows that the majority of the 37 respondents (84%) have a medium level of proficiency in Computer Science subjects. This is followed by 11% with a basic level of proficiency, and only 5% with an excellent level of proficiency.

This data suggests that most Computer Science teachers have a good understanding of the subject matter, but there is still room for improvement. The relatively high percentage of teachers with a basic level of proficiency is concerning, as it suggests that some teachers may not be fully prepared to teach this subject.

Teachers' Proficiency

There are 3 chapters in both Form 4 and Form 5 Textbook. Data collected shows that most of the respondents understand each of the topics for both textbooks. The main concern of the respondents is in delivering the subject contents for Form 4 textbook is Chapter 2: Relational Database. It is indicated, more than 10% respondents consider each of the subtopics are in the range difficult and very difficult. This may be due to the theoretical part that needs to be understood and delivered on the relational database. The data also shows that there is a lack of resources within the chapter.

Furthermore, for Form 5 textbook, Chapter 3: Web-based Programming, more than 10% respondents find each of the subtopics are in the range difficult and very difficult compared to other chapters. The data collected from the questionnaires shows that, Computer Science is a rapidly evolving field, including web-based programming. Thus, it could be difficult for teachers to keep up with the latest advances within these topics.

Suggestions

Figure 6

Teachers' suggestions.

Kursus	ABM, video dan nota bergrafik	Kursus bersemuka	Latihan yang pelbagai bentuk untuk menarik minat murid dan sekaligus dapat meningkatkan
	Bengkel bersemuka teknik mengajar bab twtsebut	Kursus by topik	Membuat kursus untuk setiap topik-topik yang terdapat dalam silibus
Bengkel	Buku rujukan yang sesuai dan bertepatan.	Kursus dan bengkel	Memperincikan Kandungan Buku Teks..... Ilmu Sains Komputer luas, perlu tertentukan tahap
	Kursus atau bengkel	Kursus kepada guru guru	Mengurangkan sebahagian kandungan.
Kursus, bengkel, video pembelajaran	Kursus berkaitan pembangunan aplikasi java menggunakan GUI	Kursus yg sesuai	Modul berstruktur yg perlu dihabiskan secara berurutan

Within the open-ended comment on aid needed to facilitate teachers in delivering Computer Science lessons, the data collected provide some general insights into understanding the difficulties of teaching computer science subjects from teachers' perspectives.

- Some teachers may be transitioning from teaching other subjects to teaching Computer Science.
- Some teachers may be teaching Computer Science as a second job or as a volunteer.
- Computer Science is a relatively new subject, so there may not be as many experienced teachers available.
- Computer Science is a rapidly evolving field, so it can be difficult for teachers to keep up with the latest advances.

However, the data strongly suggest that there is a need to develop more training and support programs for Computer Science teachers, especially those with less experience. This will help to ensure that all teachers have the knowledge and skills they need to teach this subject effectively.

Therefore, based on the findings above, training and support programs which grouped together called ProPEnC is recommended for implementation:

- Pro - Provide teachers with access to up-to-date resources.
- P - Partner with businesses and organizations to provide teachers with hands-on experience in CS.
- E - Encourage teachers to participate in professional development opportunities.
- C - Create a culture of collaboration and support among CS teachers.

It is hoped that, by providing the right aids towards the teachers, they could improve their proficiency level of teaching CS subjects. Thus, producing excellent students in the field of computer science.

CONCLUSION

In conclusion, the research is undertaken to gather insight from experience school teachers in delivering CS subject. Besides, this research emphasized the importance of supporting both experienced and less experienced teachers in effectively delivering CS education. The findings suggest the need for tailored training and resources to enhance teachers' proficiency, particularly in addressing the challenges posed by dynamic subject matter and varying levels of experience. ProPEnC is a suggested training and support programs for teachers. By implementing these recommendations, the aim is to empower teachers to deliver high-quality instruction, ultimately fostering the growth and excellence of students in the field of CS.

ACKNOWLEDGEMENT

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