

The potential value of coding to the education experiences of students and their future aspirations

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INTRODUCTION

The interplay between economic progress, social background and the potential for coding and for digital technologies to provide ‘leapfrogging’ opportunities to disadvantaged students has policy implications for an increasingly connected world. Research has identified three digital divides: the first is related to access to and use of the Internet; the second concerns access to digital services; and the third pertains digital skillsets (Ragnedda & Kreitem, 2018). India provides an unusual context to the digital divide in that it has poor Internet penetration. Yet, a key driver of its economic growth has been the IT sector, supported by many public and financial services becoming digital in the country. While the study of information technology has been part of India’s national curriculum for decades, the variation across schools has been considerable, distinguished mainly by socio-economic conditions of the students. There have been limited studies of digital inequalities in India, specially related to how digital literacy and coding skills could transform school student’s educational experiences and help bridge the socio-economic divide.

Coding skills have been identified as a key success factor for society (Tuomi, et al., 2018), including the use of computing devices such as the Raspberry Pi and its Code Club. Countries such as Australia, UK, and Estonia – currently the EU digital capital - have introduced coding in primary and secondary schools, even though there is the recognition that teacher knowledge in coding is still scarce, thus leading many schools to not being equipped with the necessary skills to answer to such societal requirement. School students learn much of their digital skills through self-learning and peer-to-peer approaches (Samuelsson, 2012). However, this is not a straightforward practice as ‘there is digital stratification related to socio-economic factors and it appears as variations in the way that ICT is used [with]social background affect[ing] the use of ICT among young people” (ibid, 2012).

This research study examines the potential value of coding to the education experiences of students and their future aspirations. The broader global perspectives are discussed in the context of a specific study in India. India has seen rapid GDP growth through exports of information technology services, but where deep inequalities persist in school education. Specifically, the narrative inquiry looks at disparate schools in the same local region in western India, where coding and increased use of technology have been introduced. The research examines the purpose of the coding initiative, the class issues involved (which in

India are often interconnected with economic disparities), and the potential motivators for the type of education practised in schools.

This study is of importance because research on coding in schools is scarce as is knowledge about the impact of coding on the educational experiences of students and the potential value of coding to their education and future aspirations. The lack of work in this critical area shows an important gap in knowledge that requires empirical work.

LITERATURE REVIEW

Literature indicates that technology education (including coding) can shape the aspirations of students. Still, it is not clear what influence there is of coding on student outlook for their future (Ardies, J., De Maeyer, S. and Gijbels, D., 2015). The study argues that if the goal of technology education at school maintains to promote 'a larger number of students in technological oriented studies and professions', there is still much to do, and further research is required in whether coding shapes the outlook of students about their future. The need for further research is supported by Hur, J. W., Andrzejewski, C. E. and Marghitu, D. (2017), who have likewise suggested that students are typically optimistic about learning Computer Science. Still, they have limited knowledge of and experience with computer science. Specifically, two crucial factors in motivation for coding are the students' affinity for and confidence in participating in ICT programmes.

Research also indicates that students may get direct academic benefits from learning coding, which is a further area that requires exploration. Coding provides an engaging way of exercising complex generalized and higher-order thinking skills in students. It also furthers the values of cooperation and collaboration (Falloon, G., 2016). Park, H., Lawson, D. and Williams, H. E. (2012) and Bowers, Alex J., and Matthew Berland (2013) have both argued that technology (and possibly coding) could perhaps change attitudes and performance in academic subjects.

However, the interest that students have in coding plays an important role in the outcomes it has for them, and research indicates that the approach used by students while studying programming had a significant impact on their outcomes. Students attitudes were influenced based on whether they received problem-based or descriptive learning (Yağcı, Mustafa, 2018). Further, there is a difference in the attitudes males and females have regarding the use of ICT which can play a role in what interests each of them as well as further aspirations

related to the field, which needs to be further explored in the research study (John Hattie and Donald Fitzgerald, 1987).

As IT becomes an increasingly important part of the learning process, the digital divide poses issues not only of learning but also social and economic challenges (Papert, 1996). Venkatesh and Brown (2001) stated that home computer usage had both utilitarian and leisure outcomes. From a utilitarian perspective, home computer usage is used for school academic commitments, presentations and programming as well as information gathering (Selwyn 1998).

Literature also indicates that students are influenced by their family and peer group in finding inspiration for coding. However, it is unclear what factors from the family background and peer group influence students, and these aspects are worth further research. Duncan, O., Haller, A., & Portes, A. (1968) found that peers can influence the goals and aspirations of students, especially when the peers come from the same socio-economic background (also explored in Hay, et al, and in Sutton, 1991, in the context of computers in schools). In general, parental support is important for educational aspirations and attainment and this research study will also explore the difference of opportunities given to the girl child (McCarron, G.P., & Inkelas, K.K., 2006). Further, the research study will examine whether the number of siblings, particularly in deprived families, may affect the aspirations of students related to coding and information technology (Qian, Z., & Blair, S. L., 1999).

Aspirations in the Indian context not only refer to a longing for social mobility or achieving an educational or occupational status but also for an identity of a “global Indian” which is specific to India’s recent urban transnational elites (Radhakrishnan 2009, 2011). Despite decades of planning, India is still a long way away from obtaining social and economic equality for a large section of its people. As far back as 1966, there was a growing feeling of concern that the development of educational facilities was only benefiting the privileged sectors of the population. Over 50 years later, this is still prevalent with the quality of education available for those who can afford to pay a higher fee being far greater than that of government schools without adequate facilities. The Education Commission recognized that while it was the duty of the educational system to provide good education to all children from every section of society, schooling was only available to those who could pay (Ministry of Education, Government of India 1966: 10).

RESEARCH METHODOLOGY

The main research question of this study is: **What is the potential value of coding to the education experiences of students and their future aspirations?**

To address the research question, the study uses a narrative inquiry to examine the secondary questions:

- What impact does teaching code in schools have on the educational experiences of students?
- How does the socio-economic status of students affect their perspective and practice of learning to code?
- Can learning code influence the education and future aspirations of school students? If so, how? If not, why not?

The Raspberry Pi Foundation, which is on a mission to put the power of computing and digital making into the hands of people all over the world (Raspberry Pi Foundation, 2018), has supported and established Code Clubs at three very different schools in Udaipur (in western India). This project will conduct a comparative case study with these three schools:

- **School A:** An independent school with a rich tradition of comprehensive education for children from modest-income middle-class backgrounds;
- **School B:** A more recent independent school with students from a higher-income middle-class background;
- **School C:** A low-fee, state-supported school for economically deprived children.

The methodology used was that of narrative inquiry, using semi-structured questionnaires to guide interviews with students of the three schools. Research using narrative inquiry 'represents a change in focus from individual meanings to cultural narratives and their influence on people's lives' (Hunter, 2010, p44). This research makes use of primary data from the interviews and set these in the context of literature and other research studies. The focus of the research and the research questions is the views of the school students.

As the participants in the research were below the age of 18 years, consent for the interviews was taken from the participants and from the school (in guardianship of the students and as gatekeepers), through written statements and at the start of the interviews. Due to the constraints of COVID-19 for the fieldwork in July and August 2020, the interviews were conducted using video conference. Most interviews were for about 30-45 minutes, and the target participation was about 20-25 students across the three schools.

Ethical approval for this research was received from the Ethics Committee of the School of Education at Durham University in July 2020 (reference number: EDU-2020-07-05T14:15:40-fflk78).

DISCUSSION OF DATA

There were 28 interviews of students in grades 6-12 across the three schools¹, as below:

- School A: 8
- School B: 12
- School C: 8

Of the 28 respondents, there were 14 girls and 14 boys.

Family background

All the students came from small families, with few siblings, as below:

- Only child: 9
- One sibling: 10
- Two siblings: 9

School A

For 7 students, the father had a job and the mother is a housewife, while one student, the mother worked as a school-teacher. In all cases, the mother was the primary care-giver at home. Of the 16 parents for the 8 students, only 5 had university degrees, and most had not completed their schooling. The parental professions included:

- Teacher (in a government school or at university)
- Wedding photographer
- Taxi driver
- Home cleaner

¹ **School A:** An independent school with a rich tradition of comprehensive education for children from modest-income middle-class backgrounds;

School B: A more recent independent school with students from a higher-income middle-class background;

School C: A low-fee, state-supported school for economically deprived children.

- Television repairman

School B

Most of the parents of the 12 children had university degrees, and all but 3 parents had completed their schooling. There were 4 parents who had graduate academic and professional qualifications. The families were relatively wealthy and regarded themselves as upper middle-class, except for 3 families who were not as well-off as the others. The parental professions included:

- Self-employed professional (services sector)
- Own business enterprise (products or services)
- Taxi service
- Pharmacist
- Office assistant
- Electrician
- Designer

School C

Only 2 parents of the 8 children had university degrees, and most of the others had not completed their schooling. While the mothers were the primary care-givers at home, both parents needed to work to support their family. The family income was low but stable. The parental professions included:

- Shopkeeper
- Newsagent
- Sewing and hair dressing services
- Clerk in a private company

Family support for education

School A

Without exception, all the respondents felt that their parents prioritised their education. Education was viewed as extremely important and parents supported academic and technology education. Phrases used by the respondents included:

- Education is very important. Parents are supportive and helpful as well as talk about aspirations.
- Education is important in the house and parents support in all endeavours.
- Parents prioritise education, encourage extracurriculars. Brother uses technology and is a coder.
- Education is viewed as crucial.

- Education is seen as a priority and coding and technology are encouraged due to belief that the world is highly digitized
- Parents both guide and teach their child.
- Family considers education very important and fully supports the student.
- Education is seen as an overwhelming priority.
- Despite both parents being illiterate, education is considered incredibly important and parents support the student in gaining more knowledge as well as technical knowledge.
- Education is very important and is supported by parents.

For a student who was interested in a career in the music industry, the parents wanted him to complete his school education and consider university, before he starts with music.

School B

Without exception, all the respondents felt that their parents prioritised their education. Education was viewed as extremely important and parents supported academic and technology education. Phrases used by the respondents included:

- Education is considered very important.
- Education is a priority in the family and the student is fully supported by parents, who maintain computers are important.
- Education and higher education are seen as a priority in the family, parents fully support him in all his educational endeavours.
- Parents encourage and prioritise education, enable the child to go for private tuition and increase the child's confidence in IT and academics.
- Parents prioritise education and encourage all educational activities and support for all educational purposes.
- Education is viewed as very important and parents are supportive.
- Education is considered very important. The father, particularly, supports coding and encourages the student to study further.
- Parents view education as a priority and are very supportive and helpful.
- Family considers education very important and fully supports the student.
- Education is considered very important and there is full parental support.

For one student, there was a mismatch of aspirations with her parents. The parents want her to be a doctor, while she wants to be a dancer and a designer. Her father keeps reiterating the importance of learning computers and how future jobs will all require technology.

School C

Without exception, all the respondents felt that their parents prioritised their education. Education was viewed as extremely important and parents supported academic and technology education. Phrases used by the respondents included:

- Education is seen as very important and parents support his desire to study computer science in the future. Elder sibling helps with school work as the parents are uneducated.
- Education is very important and gets full support from parents. The student would ask his father for help with school work in lower classes, but not relies on his teachers, as the parents have not completed their schooling.
- Education is important and parents are very supportive.
- Parents are very supportive and want the student to participate in every activity. They are not wealthy, but believe education is very important. Therefore, they help with schoolwork where they can and get private coaching support for her.
- Education is seen as a priority and parents are very supportive. However, as the parents are not educated, she relies on her elder brother for help with school work.
- Parents support him and help him however they can.
- Parents support her and her elder brother helps with work and planning her future.

Digital divide

The level of digital divide differed for students in the three schools and was largely dependent on family income.

In School A, there was usually one Internet-connected computer or mobile device at home and there was competition for use of that single device from parents and siblings. This reflected a first-level digital divide. The students want to keep on continuing to learn coding but were unable to do so from home and would thus want more classes and computer time at school.

For students in School B, there was availability of at least one Internet-connected computing device at home. However, there was a general lack of usage and understanding, a low confidence in general, except for when guided by the school. This ties into the second and third-level digital divides. Almost all students were able to effectively join online learning classes, but there was competition for devices even for students in School B. For a student whose parents had lower educational levels, the school plays a major role in influencing his computing decisions. He felt that coding had changed his life and his primary career aspiration was to become a programmer. However, due to being exposed to coding at a late stage and the lack of university education of his parent, he does not have a plan to be able to achieve his dreams in coding.

Students in School C had very little access to devices and the Internet at home, leading to a first-level digital divide. The pandemic had required use of the Internet for online learning and this was a challenge for most students. The school had encouraged the purchase and use of cheap mobile devices for online learning, but these devices were not suitable to learn and practice coding at home.

What created the interest in coding

School A

Students at School A drew their interest in coding from two main categories of persons:

- Teachers at their school who introduced them to coding
- Siblings who were already learning coding

Remarks made by the respondents included:

- Teacher told about coding and made her want to
- Due to his sisters learning coding and his desire to learn more than what his sisters could teach him, he started coding
- Wanted to code due to a deep interest and to gain an insight and education and got interested from the school teachers
- Was not interested but changed her views due to her younger brother learning and talking about it at home
- Been learning computers for a while but teacher influenced to join the Code Club, due to the possibility of making animations and learning more and learnt how to do animations and codes
- Attended a trial class where they taught Scratch and that made him want to code more

School B

Students at School B drew their interest in coding from four main areas:

- Teachers at their school who introduced them to coding
- Siblings who were already learning coding
- Friends and peer-group
- Recognition that future jobs will require computers and coding

Remarks made by the respondents included:

- Recognition that future jobs will be computer based and the usefulness of computers but low interest in coding
- Game and app development interests him the most as he wants to do it in the future alongside accountancy
- Learned coding in school and developed an interest as the teachers projected coding as innovative and new
- Just started to learn coding as he believes it can help his future in a tech-oriented world. School teacher inspired him to code.
- In 7th grade, teacher introduced HTML and then in 8th grade he was introduced to the Code Club, Scratch, HTML and CSS. He is now in 12th grade and is the President of the Code Club.

- Friends told him about the Code Club. His uncle does computer editing and he has drawn inspiration from his uncle.
- She was picked by the teacher to join the Code Club and started to learn how to code in 4th or 5th grade.
- Got interested when his sister came home and started talking about coding.
- Heard about coding from classmates and started learning in 2019.
- Started coding in 11th grade and chose it due to his passion for game development and the possibility of a career in this area.
- Had an interest in gaming and then started learning coding and stuck with it due to gaming.
- Teacher in school got him into coding and gave an introduction about it.

School C

Students at School C drew a more direct connection between coding and future job prospects. They had, universally, been introduced to coding through their school teachers.

Remarks made by the respondents included:

- Got interested in coding because of the possibility of making games and due to teacher saying coding will come in handy and suggesting he does it in the future as a career.
- Teacher in school approached her to code and suggested that she do a technical course in coding after school.
- Started to code in 9th grade and got interested due to the possibility of making and selling games and animations etc.
- Very interested in computers and coding because she thinks it's very important but doesn't want to get dependent on it.
- Wanted to start coding due to technology being important and computers being necessary for the job market.
- Wants to start coding to create his own games but hasn't started as yet.
- Teacher introduced her to it. She started learning coding because it will help her in the future.

What interests you in coding

School A

Students at School A seemed to be keen on animations and cartoons. Responses included:

- How I can constantly learn new things
- Making cartoons on computers
- Likes to learn new things and so using computers makes him feel good and he wants to develop his own apps
- Enjoys making animations

- Making animations

School B

Students at School B were more interested in learning the coding language and in developing games. Responses included:

- Game and app development interests him the most
- Finds coding limitless and so can keep learning new things; the Code Club and coding bring his imagination to real life
- Likes Scratch the most and making games. Feels he is learning something new and with computers, especially in an increasingly digital world
- Scratch interests him the most
- Scratch and making games and apps
- Game development as he wants to be a game developer

School C

Students at School C liked to make games and animations. Responses included:

- In coding, you can give instructions and see the result which she likes and appreciates
- Likes to do animations
- Making and creating things due to coding are her favourite things to do
- Likes coding due to the sounds and animations and creating things herself

Impact of coding on other academic work

School A

Four of the students in School A felt that there was a positive impact of coding on their other academic work. Responses included:

- Increased principles of logical thinking and problem solving
- English has improved
- Discipline and the desire to practice has increased
- Increased self confidence

School B

Seven of the students in School B felt that there was a positive impact of coding on their other academic work. Responses included:

- Higher order thinking increased through her knowledge of AI and coding and this has helped with math due to an increase of logical thinking

- Coding has led to his memory improving and finds small correlation between coding and math and science
- Feels there is a correlation between coding and science and math but there has been no real help in improving marks
- Made him more comfortable with computers, he uses computers and tech for research
- Uses computers for school projects
- Interest has changed and he wants to do coding instead of business studies
- Memory increased and confidence has risen due to the ability of making videos and games

School C

Four of the students in School C felt that there was a positive impact of coding on their other academic work. Responses included:

- Feels that coding helps with other subjects and uses coding to make projects about space and varied topics which allows him to increase his knowledge base
- Coding skills have helped with increased levels of discipline
- Thinks his mind has developed due to coding
- Due to coding and her interest in it, feels she has begun showing interest in other subjects too

Role of coding on education aspirations and the future

School A

For students in School A, learning coding has opened an additional avenue for the future. Most students are actively considering coding or computers as a career or an education pathway that would enhance their career prospects.

Responses included:

- Primary aim is to be an actor; if that doesn't work out, I want to code.
- Wants to be a doctor and have her own hospital. Envisions this to have computers and so wants to be proficient in computers and to learn how to code on the side.
- Wants to be an engineer and so sees coding and computers as essential for his future.
- Believes going into engineering and being a pilot will be fields where computers will be useful, tech will be used in all fields.
- Unsure if tech and coding will be helpful, unsure if she wants to take it as an academic subject in the future and unsure of what she wants to do in her future.
- Wants to be a musician, cricketer or start a business. Will consider computers and coding as a potential avenue for the future. Believes for business, knowledge of computers and coding are necessary.

- Dependent on how he does in 8th and 10th, will want to go into the Indian Institute of Technology (premier engineering university in India). Coding has helped increase his interest in computers and technology; this allows him to learn more.
- Has not thought much about future but wants to do coding in higher classes and believes computers are necessary and learning them is important.

School B

For students in School B, using computers have been part of their lives. Additionally, many students have a good idea of their future careers. However, learning coding has widened their horizons.

Responses included:

- Does not want to pursue computers or tech but doesn't mind learning it, wants to learn the daily use of computers and does not know if computers will be useful for further education but tech (phone and internet) used right now for her academic activities.
- Wants to be an architect. Believes computers are incredibly important for the next generation and has used it for her own work and wants to learn coding beyond school as well.
- Wants to do accountancy. Believes knowledge of coding and technology will help in data manipulation and to make tables, also has a passion for app development and considers it a backup for if accountancy doesn't work and he wants to learn coding further to develop his own games.
- Believes coding will be very important for his future and wants to make a career out of coding; wants to become a software engineer.
- Wants to continue coding further; thinks the world is going to an increasingly digital place.
- Believes technology is very important and will play a role in everyone's future.
- Believes computers are necessary to 'make houses', which is what he wants to do. He recognised that modern architectural designing is done on computers.
- Believes learning coding and computers will be important for the future and specially to get a job. Hence, wants to continue studying coding further in school.
- Believes coding and computers are very important for all jobs and there is a larger need to know it with increased digitalization. He wants to be a game developer though he does not know how he will do it and wants to do more studies related to coding after 12th grade. Since he started coding, interest has changed from business to coding.
- Thinks coding and computers are important for gaming purposes as well as for the availability and usage of computers all over the world but doesn't want to do coding in higher classes.
- Wants to do further studies and become a doctor. Believes computers will be necessary and give knowledge and so wants to learn coding further and likes coding the most of all her subjects.

School C

For students in School C, learning coding has opened an additional avenue for the future. Most students are actively considering coding or computers as a career or an education pathway that would enhance their career prospects.

Responses included:

- Wants to do computer science in the future and sees coding as an integral part of that.
- Wants to do something related to computers and science when she grows up. The computers aspect has come along due to her interaction with the code club.
- Wants to do a government job and so wants to do an undergraduate science degree. Thinks knowing how to code gives her an advantage.
- Wants to work in banking and believes computers will be very important in banking and wants to learn more coding.
- Thinks coding and computers can help in the future because you can get answers to things immediately and it is helpful to know.
- Wants to learn more about banking through government colleges and thinks coding and knowledge of computers is necessary for jobs.
- Wants to become a chartered accountant and believes coding will help her in the future.

Additional remarks of interest from participants

School A

- Has been using computers since 4th grade. Observes his father using the computer. Believes computers will be necessary in the future due to emails, meetings etc and for writing applications. Both sisters also know how to use computers and uses internet to clear doubts and uses computers at home and school.
- Uses home computers to teach herself more than what she learns in class. Father has some knowledge of using computers, but she learns most things by herself. Has only recently started learning coding and tech. Believes tech will be used in all fields and uses it for her education.
- World is heading towards higher level of technology and so is India and so believes it is necessary.
- Parents are overwhelmingly supportive, despite not earning much; have bought him a computer to practice coding at home. He does more than what is asked of him from the code club, he creates more. Code club helped him gain interest in computers.

School B

- Uses computers to enhance knowledge and use the Internet. His brother and he develop games at home and school. They use YouTube to learn more coding than what

is taught at school. Earlier used to use computers to play games and now can create them and hence, he feels his confidence in himself and self-belief has increased.

- Her parents use computers extensively at home, but she does not and she uses tech very sparingly at home.

School C

- Got confidence due to code club and wants to move forward with it
- Takes help from teachers and older brother and has increased confidence in using computers due to the code club
- Wants to teach her brother how to code as well as wants to learn more and then talk more about coding and teach others because she believes coding is important and a skill everyone should know

CONCLUSIONS

This research study has established that there is a positive aspirational impact of learning coding on the future aspirations of students at three diverse schools in Western India. There are significant differences in access to technology based on income and the three-levels of digital divide play out in different ways at the schools. However, clearly, all the parents are keen on the education of their children and are willing to go beyond what they might easily be able to afford to support the learning of coding.

This research, however, most effectively highlights that the future aspirations of school students has definitely been influenced by learning code. For most students, coding has made them reassess their career goals, to think of new technology-related careers, or to recognise the support learning code can have for many career options. Students in School B, possibly having greater exposure to career pathways at home through the higher education and income levels of their families, had clear career goals that were influenced by learning coding. Teaching code in schools has had the most positive impact on students in Schools A and C, where their educational experiences have been enhanced. There is evidence in the narratives of students gaining self-confidence and having a greater belief in their ability through coding, and this has shown some influence on other academic areas.

While this research study has indicated that learning coding can influence and has a positive impact on the future aspirations of students, greater and more in-depth research is required.

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