

A Pilot Study Investigating Teachers' use of Video Games in Programming Lessons

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Abstract: Education systems worldwide are increasingly incorporating computer programming into school curricula. Within programming lessons, commercial, off-the-shelf (COTS) video games are being used as part of instruction. This approach has been shown to deliver many benefits, including increased engagement and positive attitudes towards the subject. Empirical studies have demonstrated that carefully selected COTS video games, primarily designed for entertainment purposes, have the potential to support pupils learning to program. For example, teachers can connect abstract programming concepts with concrete elements within the game. However, little attention has been directed towards the pedagogy employed in the classroom, including teachers' reasoning for the approaches used. In addition, there is limited evidence for the motivation for learning provided through the use of COTS video games when used to support the learning of programming concepts. The objective of my study is to examine teachers' and pupils' perspectives on how COTS video games are used within computing education to support primary (9 - 11 years) aged pupils' learning of programming concepts. The findings from my exploratory study will provide insights into classroom practices and contribute to the collective pedagogical content knowledge (PCK) for teaching programming. A qualitative, multiple case-study approach is used in this research. Schools are visited when a lesson involving the use of COTS video games to support pupils' learning of programming concepts is being delivered. Teachers' PCK is examined through investigating their pedagogical reasoning. For a planned lesson, data is captured through the completion of a Content Representation (CoRe) and a semi-structured interview. Teachers' pedagogical reasoning for their instruction and their subsequent reflections are elicited using an episodic narrative interview based on a video recording of the lesson. Self-determination theory is used to examine both teachers' and pupils' views on motivation for learning. Semi-structured interviews enable them to discuss intrinsic motivation and the fulfilment of their basic psychological needs. A pilot study has recently been completed in an English primary school. Within this paper, an initial analysis of the data is presented.

Keywords: Video games, Primary education, Programming, PCK, Pedagogy, Motivation

1. Introduction

The need for children to learn computer programming is recognised as a vital part of their education (Mannila & Heintz, 2023). There are many benefits of learning to program, including developing children's problem-solving skills (Fagerlund et al., 2021) and increasing their understanding of computing technology (e.g. (Alam, 2022)). Across the globe, programming has been introduced within school curricula, including England (Department for Education, 2013), which is my study's areas of investigation. However, there have been many challenges to introducing this new curricular content (Royal Society, 2018). In particular, many teachers are unfamiliar with the subject having never studied it themselves. They therefore require support to develop their pedagogical content knowledge (PCK), as posited by Shulman (1986). Teachers with well-developed PCK are able to promote effective learning within their subject, including during computing lessons (Nijenhuis-Voogt et al., 2023). Whilst empirical studies have attempted to define the PCK required to teach programming (e.g. Hubwieser et al., 2013; Saeli et al., 2011), the proposals are often secondary specific and lacking in empirical validation. A number of the pedagogical approaches used to teach programming to primary pupils can be disengaging (Socratous & Ioannou, 2021). Empirical studies have also highlighted how pupils can find programming concepts challenging to learn (Sentance et al., 2017; Yadav et al., 2016).

Commercial, off-the-shelf (COTS) video games, developed for entertainment purposes, such as Pac-Man and Frogger, have been identified by teachers as increasing pupils' motivation for learning when used as part of their lessons' instruction (e.g. Allsop et al., 2015; Wastiau et al., 2009). The use of video games forms an integral part of primary aged children's daily lives, with the Children's Commissioner of England (2024) recently outlining how their most common motivation for playing is "to have fun" (p. 7). Ryan et al.'s (2006) empirical studies have demonstrated how individuals experience pleasurable feelings, such as fun and enjoyment, when playing video games. Video games are therefore seen as intrinsically motivating for the player through the inherent satisfaction they provide. Self-determination theory (SDT) (Deci et al., 1985) posits this motivation is fostered through the fulfilment of an individual's basic psychological needs.

Few empirical studies have examined the use of COTS video games to support primary aged pupils' learning of programming concepts. Within existing studies, there is limited evidence of the pedagogical approaches employed (e.g. Franklin et al., 2020; Basawapatna et al., 2019; Lakanen et al., 2019). In particular, these studies

fail to elicit teachers' PCK and their reasoning for the teaching methods used. Whilst a single study has been identified that collected data related to pupils' views on motivation for learning (Repenning et al., 2015), there is a lack of analysis in relation to motivational theories, such as SDT. Therefore, little is known about how COTS video games are used to support the learning of programming, such as teachers' knowledge and reasoning for the pedagogy employed. In addition, there is minimal empirical evidence on teachers' and pupils' perspectives regarding motivation for learning. My research aims to address these issues through examining the research questions outlined below.

2. Conceptual Framework

2.1 Pedagogical Content Knowledge (PCK)

Shulman (1986) introduced the concept of PCK and highlighted how it is a "special amalgam of content and pedagogy that is uniquely the province of teachers" (Shulman, 1987, p. 8). Shulman outlined how teachers need well developed PCK of subject specific content to facilitate effective pupil learning. Due to the multiple categories of a teacher knowledge that Shulman proposes make up their PCK, the concept is considered more complex than originally proposed (Kind, 2009). Refinements to Shulman's original definition therefore often add further components (e.g. Gess-Newsome, 1999; Grossman, 1990). Magnusson et al.'s (1999) conceptualisation is the refinement most cited within empirical STEM subject PCK research (Mientus et al., 2022). This includes when studying teachers of primary aged pupils (e.g. Hanuscin et al., 2011) and in computing education (e.g. Nijenhuis et al., 2023; Yeni et al., 2021; Barendsen et al., 2014).

The Refined Consensus Model (RCM) of PCK (Carlson et al., 2019) highlights how a range of broad, "professional knowledge bases" (p. 82), such as assessment knowledge and content knowledge, form a foundation for teachers' PCK. The RCM is often used within empirical studies examining classroom practice (e.g. Larsson et al., 2023), as it recognises the importance of a teacher's enacted PCK (ePCK) - the knowledge and skills an individual uses in a certain setting, with specific pupils, in order for them to learn aspects of the subject being taught. Empirical studies examining ePCK (e.g. Forsler et al., 2023; Behling et al., 2022) have highlighted how ePCK is influenced by a teacher's pedagogical reasoning (Shulman, 1987) - the cognitive processes employed when planning, delivering and evaluating instruction. A teacher's ideas, values and beliefs are seen as an integral part of these cognitive processes (Webb, 2002). A teacher eliciting their pedagogical reasoning, such as through stating their "reasons for a specific action" (Larsson et al., 2023, p. 591), can provide an insight into their PCK.

2.2 Self-Determination Theory (SDT)

Deci and Ryan's (Deci et al., 1985) Self-determination Theory (SDT) is a macro-theory of human motivation and personality (Ryan et al., 2023). SDT distinguishes between different types of motivation, including intrinsic and extrinsic. When individuals are intrinsically motivated, they engage in activities that provide them with inherent satisfaction - the experience of fulfilment from engaging in the activity itself. Extrinsic motivation involves the use of external factors, such as rewards, to engage individuals in activities (Ryan et al., 2020). SDT also posits that all humans have three basic psychological needs – autonomy, competence and relatedness (Ryan, 1995). When these needs are fulfilled, individuals experience psychological growth and well-being. The SDT mini-theory of Organismic Integration Theory (OIT) (Ryan et al., 2023) is of particular interest, as it posits the fulfilment of an individual's basic psychological needs leads to autonomous forms of motivation; including intrinsic motivation. Guay's (2022) systematic review highlighted the importance of autonomous forms of motivation in pupils' persistence and academic success within school.

Empirical studies (e.g. Ryan et al., 2006) have demonstrated how the playing of COTS video games can foster intrinsic motivation through fulfilling an individual's basic psychological needs. Studies involving primary / elementary aged children (e.g. Hamlen, 2011; Sherry et al., 2006) have highlighted how the fulfilment of basic psychological needs is also evident when children play COTS video games. Empirical studies examining the relationship between the perceived fulfilment of basic psychological needs when playing a COTS video game and motivation for learning have recently been undertaken (e.g. R  th et al., 2021). However, it is unclear to what extent the results are applicable to computing education.

3. Aims

My research aims to explore how COTS video games are used to support primary (9 - 11 years) aged pupils' learning of programming concepts. The overarching research question is:

How are commercial, off-the-shelf (COTS) video games used by teachers to support primary aged children's learning of programming concepts?

The following specific research questions have been identified:

RQ1 - How is pedagogical content knowledge (PCK) evident through pedagogical reasoning within participant teachers' lessons that use commercial, off-the-shelf, video games to support pupils' learning of programming concepts?

RQ2a - How do participant pupils perceive the motivation for learning provided by commercial, off-the-shelf, video games when they are used to support their learning of programming concepts?

RQ2b - How do participant teachers perceive the motivation for learning provided by commercial, off-the-shelf, video games when they are used to support pupils' learning of programming concepts?

4. Methodology

My study uses a qualitative, multiple case study approach, which enables comprehensive data to be gathered on participants' views (Stake, 2006). A pilot study has recently been undertaken, as described in the next section. Five further schools will be visited when a teacher is delivering a lesson where COTS video games are being used to support primary aged pupils' learning of programming concepts. For RQ1, prior to the lesson taking place, the teacher completes a Content Representation (CoRe) (Loughran, Mulhall & Berry, 2004). A CoRe document enables teachers to elicit their planned ePCK through responding to specific prompts. This is followed by a semi-structured interview to ensure teachers' pedagogical reasoning is articulated for the planned instructional approaches. The teacher then delivers the lesson, which is video recorded. Parts of the video recording are viewed with the teacher following the lesson and discussed during an Episodic Narrative Interview (ENI) (Flick, 2000). The ENI enables teachers to elicit their pedagogical reasoning for the ePCK during instruction and when reflecting on the lesson. For RQ2a and RQ2b, SDT facilitates the examination of both teachers' and pupils' perspectives on motivation for learning. Semi-structured interviews are used to investigate participants' views on the fulfilment of their basic psychological needs, intrinsic motivation and their interest in the topic being studied.

To analyse the data, Yin's (2015) five stages of data analysis are followed. Interview data is transcribed and coded. Deductive coding is first used, with initial codes defined based on the related theoretical perspective (Bryman, 2016). Relying solely on pre-defined codes can limit the ability to identify new insights, so inductive coding is then undertaken. This is important for my study, which is exploratory in nature and might identify perspectives that have not previously been considered. A thematic analysis, in conjunction with analytical memos, enables the production of case study profiles and a cross-case analysis.

5. Pilot Study - Overview

A pilot study was recently undertaken to ensure the proposed methods could be used successfully in a school setting and that suitable data was produced for analysis. The pilot study took place in a primary school in the north-west of England. The teacher had been qualified for over 20 years and was experienced in teaching computing. The pupils in the lesson were aged 9-10 years.

The lesson involved the use of the COTS video game *Just Dance* (Ubisoft, 2025) to develop pupils' knowledge and understanding of algorithms and debugging. During the lesson, pupils undertook unplugged (without the use of technology) activities in groups. Pupils created a sequence of dance moves, which were adapted from the video game, to produce an algorithm. The algorithm was then performed to other groups. This enabled feedback to be provided to pupils and for them to debug their algorithms.

6. Pilot Study - Results

Initial results of the analysis for RQ1 from the pilot study are outlined below. Themes are discussed in relation to a teacher's PCK within a lesson that uses COTS video games to support pupils' learning of programming concepts. The themes are discussed with reference to the four components of Magnusson et al.'s (1999) conceptualisation of PCK, which is deemed appropriate for use in conjunction with the RCM:

Knowledge of Instructional Strategies and Representations (KISR) - Teachers' knowledge of specific strategies, including activities and representations, for helping pupils understand a topic

Knowledge of Students' Understanding (KSU) - Teachers' knowledge of concepts or topics pupils find challenging to learn, or may have misconceptions. Teacher's knowledge of prerequisites to learning specific knowledge.

Knowledge of Curriculum (KC) - Teachers' knowledge of the goals and objectives of the curriculum, including instructional materials and the organisation of content.

Knowledge of Assessment (KA) - Teachers' knowledge of the aspects of the subject to assess and how this can be done.

Quotations related to each area are also included. Pseudonyms are used throughout.

6.1 Ensuring Pupils are Familiar with Parts of the Video Game Being Referred to Within the Lesson

6.1.1 Knowledge of students' understanding

When discussing their KSU, the teacher outlined how she had selected a game her class had seen before, although it was still important to ensure pupils focused on specific parts of the game during the lesson:

They know Just Dance really well, because they've done lots in class with it from in golden time ... I'm actually asking you to look at something specific within that. You're making them think before they do really, rather than just let's just do the dance routine. ... It's fun, but I'm actually saying, well, actually, I want you to look at this bit

6.1.2 Knowledge of instructional strategies and representations

To support this process, the teacher's KISR showed how they introduced the specific part of the video game at the beginning of the lesson before discussing the lesson's objectives. This enabled pupils to start thinking about what the specific part involves:

I wanted them to think about the video game. I wanted them to think about the algorithm before we got there. ... They had it when they came in ... so they knew they were going to be doing? But I think it was important.

The early familiarisation with the part of the video game also enabled the teacher to manage behaviour effectively, as immediately using the game as part of their teaching input could have led to pupils being over excited:

if I'd had just introduced that straight away [as part of the teacher input], they'd been dead excited and then ... they'd been just like high as kites and they probably would not have focused as much.

The teacher used both images from the video game and pictograms / pictocards (stick figure images) to represent dance moves from within the game, which they reported enabled pupils to interpret the game and use the moves when producing their algorithms:

it's weird. It's like subliminal, as they knew that, they all knew what that meant. ... I didn't tell them what that movement looked like, but it was interesting that they all just got into that position, didn't they? ... I also gave them the proper pictures as well if they wanted to use them, so there was a mixture of different imagery there.

6.1.3 Knowledge of curriculum

The teacher's KC outlined how a range of games that pupils are familiar with could be used within the lesson to develop pupils' knowledge and understanding, although it was important to ensure they are age appropriate:

You've got to be really careful about your gaming choice. Children are using them at home, which we know they are. ... So although they are doing [inappropriate game dances], does that ... mean I should now do a lesson on it? No, it doesn't.

6.2 Enabling all Pupils to Achieve

6.2.1 Knowledge of Students' Understanding

The teacher's KSU highlighted how some pupils find computing challenging, whereas the lesson within the pilot study enabled them to achieve:

you'll see children who may be, ordinarily, might find that a bit tricky, will have a go and they'll start to spot things and you can celebrate those children. I think it's that sense of achievement. So many times children just say I can't do it. But you say to them, just have another go and then they succeed. And that

feeling that they get when they succeed ... So you're trying to get rid of that negative emotion of, I can't do it.

6.2.2 Knowledge of instructional strategies and representations

When discussing their KISR, the teacher outlined how creating dance move algorithms related to the video game could be achieved be all:

You know, every child in there could come up with a dance move. I'm pretty sure of it. ... So that's what's nice about it, isn't it? About that unplugged idea that they all get a chance to succeed, which I think is important, you know?

The teacher outlined how this was a particular issue as pupils lacked resilience, yet they could still produce dance moves related to the video game:

resilience, is a big one, isn't it? You know ... that's a massive problem with children, as they just give up and they're not willing to have a go. And the older they get, the more embarrassing they get about making a mistake. Whereas something like this, it doesn't really matter, 'cause, it's like so fun and everyone can have a go at doing a dance move, can't they?

In addition, the teacher discussed how pupils might find parts of the lesson challenging, yet they will still be engaged due to the use of the video game:

some children will immediately switch off. Well, yeah, we're doing computing, but actually we're not going to go on a computer. We're actually going to do a Just Dance computer thing and they'll go, Oh, wow, that's exciting. So it's different, isn't it? You know, and I think that's when we talk about gaming, you know, doing something that they know and they love.

Whilst the pictograms and images outlined above could be used within pupils' algorithms, the teacher also discussed how other groups could draw or write their own moves. This enabled more complex algorithms to be produced, with the video game content used as a reference point:

For those who want to add their own [moves], well, they've got the pictograms again as a reference. Well, I need to put arrows on them, which they were doing, weren't they? ... Emily's group were very much using the pictocards, whereas Yannis's group, they wanted to draw their own. All of them created an algorithm.

Following the lesson, the teacher outlined how they had adapted their instruction by singing the song used in the video game, rather than listening to the video game itself, to ensure pupils could produce an algorithm:

And I sung it rather than played it because the actual song is quite fast. And is it about them doing it at the speed of that song, or was it about them doing the algorithm so you make that decision?

6.3 Facilitating Peer Interaction

6.3.1 Knowledge of curriculum

The teacher's KC outlined how pupils working as a team is an important aspect of the lesson, although it does not form part of the formal planning:

some of those skills, you'll think, like working as a team. You know, that'll show me a lot about those children, how they can work as a team. Because those are skills that, although it's computing, they're skills that they struggle with working as a team, you know ... I wouldn't write them in a lesson plan, but they are hidden skills

6.3.2 Knowledge of instructional strategies and representations

When examining the teacher's KISR, they highlighted how small groups are required to ensure everyone is involved. They also offer guidance to pupils on how they can work together to develop their dance moves if required:

I'll put them into small groups. So, I said 3 or 4 because any more than that, you start to argue and it's like teamwork thing again, but then a lot of the time, I'll probably say, well, how could you do this? How could you make sure that everyone has a part? ... And we all put a move in each and then maybe add one more each, you know, think about that compromise rather than like, I'm going to say we're doing this. Is that what we do as a team and all that?

After the lesson, the teacher outlined how, when working in a group, all pupils were engaged in the activities:

they were all engaged. All of them were involved in it. ... It was a leveller. ... You know, if you asked him to do it on their own, there would be some of those who would do it on their own. Granted. But a lot of them wouldn't want to do it on their own would they?

6.3.3 Knowledge of Assessment

The teacher's KA outlined how peer assessment could be undertaken through groups performing to each other, which enables algorithms to be debugged:

when they've done their algorithm, I'll say, right. OK. Groups 1, whatever, you perform to the other group. So they'll see them do their algorithm, then they'll swap over, do their algorithm, and then they'll say, OK, well, what I want you to do now is go and swap algorithms. See if you can actually act out dance out there, so they'll see it done.

6.4 Using Technical Vocabulary Throughout the Lesson

6.4.1 Knowledge of students' understanding

The teacher's KSU outlined how it is important for pupils to be clear of the purpose of the session, which requires the introduction of technical vocabulary at the start of the lesson:

So we'll talk through these first. So that they're clear of where we're going by the end of the session. Because children, like adults, like to know what they're doing ... we're doing it because we're going to write our own dance algorithm. That's what we're going to do. I'm going to use this to do it. So that's what they want to know, isn't it?

6.4.2 Knowledge of instructional strategies and representations

Their KISR outlined the vocabulary is introduced through questioning, repetition of the vocabulary and definitions, and actions for each term:

Often I'll just start with the challenge and say, what does algorithm mean, have you heard of algorithm before? And that'll tell me, that's assessing them as well. Well, so if they know what it is, I've got the slide with all the definitions on I say, OK, do you remember what we said? Algorithm. And I'll then ask them read it out. So they were just reinforcing it again. ... I've got an action for it. Here's my action, but have you heard of that word?

The vocabulary and actions are repeated throughout the lesson, which enables pupils to develop their knowledge and understanding:

going over it again and again and again throughout the session. So you're probably going algorithm about 100 times. But the thing is, it's that reinforcement of that quote. You don't say at the beginning, they'll never mention it again. Yeah, you know, so what is why I'll keep doing it every time I say algorithm, I'll do the action so that they're seeing that physical side of it as well, so they know I could just do that and they'll go, oh, yeah, it's algorithm.

The teacher outlined after the lesson how successful this strategy had been as pupils could remember the vocabulary:

And obviously the actions were great because that reinforced that vocab as well. So that was, I thought that was quite, I was quite surprised how much they remembered. That was a nice element to the first bit. So that meant that when we came to the vocab later on, it was just a case of a quick sort of recap.

In addition, it had meant pupils were aware they were learning about programming, rather than about the video game:

We're doing this because we are going to create an algorithm, so I started straight away. Yes, we're going to be using Just Dance, but it was all about the algorithm and the programming; it was all about that. ... It's a vehicle. It's a hook. It's a way to get them engaged and interested in doing that task. But ultimately there was no point that I didn't say it's not an algorithm here. We're using sequence. We're using decomposition. So it's coming back to that language.

6.4.3 Knowledge of assessment

Finally, through stating their KA, the teacher outlined how examining the vocabulary at the end of the lesson provided an opportunity to check pupils' understanding:

Because it's ensuring their understanding, it's the assessment, isn't it? Of what they've understood in that session. If at the end for example, if I'd not said this is what an algorithm is and we've gone through it again, would they remember that it's an instruction? You know, your just clarifying that understanding even though they could write one. You come in, bringing it back full circle, aren't you? And that's really important.

7. Discussion

The pilot study results provide an initial insight into a teacher's pedagogical content knowledge (PCK) within a lesson that uses COTS video games to support pupils' learning of programming concepts. The brief discussion below is organised in relation to the four components of Magnusson et al.'s (1999) conceptualisation of PCK.

The results highlight how the teacher's Knowledge of Students' Understanding (KSU) enables lessons to be delivered that they believe are suitable for their pupils. The teacher discussed the importance of selecting appropriate video games for use in the lesson. Whilst recent reports had identified the integral role COTS video games play in the lives of young people (e.g. Children's Commissioner of England, 2024), the teacher recognised they may not be familiar with the title used. They also highlighted how their pupils experience a number of difficulties when learning programming, which echo those identified within empirical studies (e.g. Sentance et al., 2017). The teacher's KSU, along with their Knowledge of Curriculum (KC), identified the need to cover the English National Curriculum for Computing (Department for Education, 2013). They highlighted many further skills, such as teamwork, will be developed. However, these skills are not specified in either the National Curriculum content or their lesson planning. These wider benefits of pupils learning to program relate to those identified in Fagerlund et al.'s (2021) systematic review.

The teacher's Knowledge of Instructional Strategies and Representations (KISR) highlighted the importance of unplugged activities; particularly as they promote active participation in lessons (Royal Society, 2018) and pupil engagement, which can be challenging in computing lessons (Socratous et al., 2021). The teacher's KISR also outlined how they can facilitate achievement by all pupils; particularly as they recognise the lack of resilience pupils can exhibit, which has been identified as an issue when learning programming (Liu et al., 2025). Limited discussion was evident in relation to the teacher's Knowledge of Assessment (KA). Approaches to assessing programming can be challenging for teachers to implement (Basso et al., 2018). The peer and formative assessment strategies used by the teacher are suggested in teaching resources used by teachers in England (e.g. NCEE, 2025).

8. Next Steps

The pilot study demonstrated the appropriateness of the methods to examine the research questions. A number of minor modifications have been made to the methodology. In particular, the introductory text for the activities has been altered to emphasise the importance of the teacher expressing their views on the use of the COTS video game during the lesson.

During the analysis, the pilot study highlighted how the teacher's perception of the motivation for learning provided through the use of COTS video games within the lesson relates closely to their PCK and associated beliefs. When delivering computing lessons, Margaritis et al. (2015) posit a teacher's "beliefs and attitudes" (p. 215) influence their PCK, such as their beliefs related to teaching and learning. In addition, the RCM of PCK and Stefaniak et al.'s. (2021) more recent proposals outline how a teacher's beliefs impact on their pedagogical reasoning. However, not all these beliefs will be evidenced through examining enacted teaching approaches (Hutner et al., 2016). Further analysis of the responses to research question R2a and R2b is therefore ongoing and not reported here.

Five further primary schools from across England will be visited over a period of around six months. The findings from my research will provide insights into classroom practices and contribute to the collective PCK for teaching programming. This will be of interest to computing teachers, researchers and teacher educators worldwide. My study will have implications for lesson design and educational resource development; particularly with regard to the pedagogical approaches employed and the instructional representations used.

9. Conclusion

This paper has outlined research currently being undertaken in English primary schools to explore how COTS video games are used to support primary (9 - 11 years) aged pupils' learning of programming concepts. PCK and SDT literature has been discussed in relation to the topic under investigation. Details of the methodology have been provided, including the appropriateness of the methods for use in schools. Results of the pilot study have also been presented, with themes identified in relation to different components of PCK. Five additional primary schools will now be visited.

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AI declaration: AI tools have not been used in the creation of this paper.

References

- Alam, A. (2022) Educational Robotics and Computer Programming in Early Childhood Education: A Conceptual Framework for Assessing Elementary School Students' Computational Thinking for Designing Powerful Educational Scenarios. In: *2022 International Conference on Smart Technologies and Systems for Next Generation Computing (ICSTSN)*. March 2022 pp. 1–7.
- Allsop, Y. & Jessel, J. (2015) Teachers' Experience and Reflections on Game-Based Learning in the Primary Classroom: Views from England and Italy. *International Journal of Game-Based Learning*. 5, 1–17.
- Barendsen, E., & Henze, I. (2019). Relating Teacher PCK and Teacher Practice Using Classroom Observation. *Research in Science Education*, 49.
- Basawapatna, A., Repenning, A. & Savignano, M. (2019) The Zones of Proximal Flow Tutorial: Designing Computational Thinking Cliffhangers. In: *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*. SIGCSE '19. 22 February 2019 New York, NY, USA, Association for Computing Machinery. pp. 428–434.
- Basso, D., Fronza, I., Colombi, A., & Pahl, C. (2018). Improving Assessment of Computational Thinking Through a Comprehensive Framework. *Proceedings of the 18th Koli Calling International Conference on Computing Education Research*, 1–5.
- Behling, F., Förtsch, C., & Neuhaus, B. J. (2022). The Refined Consensus Model of Pedagogical Content Knowledge (PCK): Detecting Filters between the Realms of PCK. *Education Sciences*, 12(9), Article 9.
- Bryman, A. (2016) *Social Research Methods*. 5th edition. Oxford, Oxford University Press.
- Carlson, J., Daehler, K.R., Alonzo, A.C., Barendsen, E., Berry, A., et al. (2019) The Refined Consensus Model of Pedagogical Content Knowledge in Science Education. In: A. Hume, R. Cooper, & A. Borowski (eds.). *Repositioning Pedagogical Content Knowledge in Teachers' Knowledge for Teaching Science*. Singapore, Springer Nature. pp. 77–94.
- Children's Commissioner (2024) *Digital playgrounds: Children's views on video gaming*. 2024. Children's Commissioner for England. Available at: <https://www.childrenscommissioner.gov.uk/blog/digital-playgrounds-childrens-views-on-video-gaming/>
- Deci, E.L. & Ryan, R.M. (1985) *Intrinsic Motivation and Self-Determination in Human Behavior*. 1985th edition. New York, Springer.
- Department for Education (2013) *National curriculum in England: computing programmes of study - key stages 1 and 2*. Available at: https://assets.publishing.service.gov.uk/media/5a7c576be5274a1b00423213/PRIMARY_national_curriculum_-_Computing.pdf.
- Fagerlund, J., Häkkinen, P., Vesisenaho, M. & Viiri, J. (2021) Computational thinking in programming with Scratch in primary schools: A systematic review. *Computer Applications in Engineering Education*. 29 (1), 12–28.
- Flick, U. (2000) *Qualitative Researching with Text, Image and Sound*. SAGE Publications Ltd.
- Forsler, A., Nilsson, P., & Walan, S. (2023). Capturing and Developing Teachers' Pedagogical Content Knowledge in Sustainable Development Using Content Representation and Video-Based Reflection. *Research in Science Education*, 54(3), 393–412.
- Franklin, D., Coenraad, M., Palmer, J., Eatinger, D., Zipp, A., Anaya, M., White, M., Pham, H., Gökdemir, O. & Weintrop, D. (2020) An Analysis of Use-Modify-Create Pedagogical Approach's Success in Balancing Structure and Student Agency. In: *Proceedings of the 2020 ACM Conference on International Computing Education Research*. ICER '20. 7 August 2020 New York, NY, USA, Association for Computing Machinery. pp. 14–24.
- Gess-Newsome, J. (1999). Pedagogical Content Knowledge: An Introduction and Orientation. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining Pedagogical Content Knowledge: The Construct and its Implications for Science Education* (pp. 3–17). Springer Netherlands.
- Grossman, P. L. (1990). The Making of a teacher: Teacher knowledge and teacher education. *Teachers College Press*.

- Guay, F. (2022) Applying Self-Determination Theory to Education: Regulations Types, Psychological Needs, and Autonomy Supporting Behaviors. *Canadian Journal of School Psychology*. 37 (1), 75–92.
- Hamlen, K.R. (2011) Children's choices and strategies in video games. *Computers in Human Behavior*. 27 (1), 532–539.
- Hanuscin, D. L., Lee, M. H., & Akerson, V. L. (2011). Elementary teachers' pedagogical content knowledge for teaching the nature of science. *Science Education*, 95(1), 145–167.
- Hubwieser, P., Magenheimer, J., Mühling, A. & Ruf, A. (2013) Towards a conceptualization of pedagogical content knowledge for computer science. In: *Proceedings of the ninth annual international ACM conference on International computing education research*. ICER '13. 12 August 2013 New York, NY, USA, Association for Computing Machinery. pp. 1–8.
- Hutner, T.L. & Markman, A.B. (2016) Proposing an Operational Definition of Science Teacher Beliefs. *Journal of Science Teacher Education*. 27 (6), 675–691.
- Kind, V. (2009). Pedagogical content knowledge in science education: Perspectives and potential for progress. *Stud. Sci. Educ.*, 45
- Lakanen, A.-J. & Kärkkäinen, T. (2019) Identifying Pathways to Computer Science: The Long-Term Impact of Short-Term Game Programming Outreach Interventions. *ACM Transactions on Computing Education*. 19 (3), 20:1–20:30.
- Larsson, A. & Stolpe, K. (2023) Exploring the metaphoric nature of programming teachers' reflections on action - a case study with teaching in mind. *International Journal of Technology and Design Education*. 34 (2), 585–602.
- Liu, W., & Hu, L. (2025). Unplugged programming practice in Chinese rural primary schools: A method to foster students' computational thinking and resilience. *Interactive Learning Environments*, 33(1), 387–407.
- Loughran, J., Mulhall, P. & Berry, A. (2004) In search of pedagogical content knowledge in science: Developing ways of articulating and documenting professional practice. *Journal of Research in Science Teaching*. 41 (4), 370–391.
- Magnusson, S., Krajcik, J. & Borko, H. (1999) Nature, Sources, and Development of Pedagogical Content Knowledge for Science Teaching. In: J. Gess-Newsome & N.G. Lederman (eds.). *Examining Pedagogical Content Knowledge: The Construct and its Implications for Science Education*. Dordrecht, Springer Netherlands. pp. 95–132.
- Mannila, L. & Heintz, F. (2023) Chapter 4 Introducing Programming and Computational Thinking in Grades 1–9. In: J. Hallström & M.J. de Vries (eds.). *Programming and Computational Thinking in Technology Education*. International Technology Education Studies. Brill.
- Margaritis, M., Magenheimer, J., Hubwieser, P., Berges, M., Ohrndorf, L. & Schubert, S. (2015) Development of a competency model for computer science teachers at secondary school level. In: *2015 IEEE Global Engineering Education Conference (EDUCON)*. March 2015 pp. 211–220.
- Mientus, L., Hume, A., Wulff, P., Meiners, A., & Borowski, A. (2022). Modelling STEM Teachers' Pedagogical Content Knowledge in the Framework of the Refined Consensus Model: A Systematic Literature Review. *Education Sciences*, 12(6), Article 6
- NCCE (National Centre for Computing Education). (2025). *Teach Computing Curriculum*. Teach Computing. <https://teachcomputing.org/curriculum>
- Nijenhuis-Voogt, J., Bayram-Jacobs, D., Meijer, P.C. & Barendsen, E. (2023) Teaching algorithms in upper secondary education: a study of teachers' pedagogical content knowledge. *Computer Science Education*. 33 (1), 61–93.
- Repenning, A., Webb, D.C., Koh, K.H., Nickerson, H., Miller, S.B., Brand, C., Horses, I.H.M., Basawapatna, A., Gluck, F., Grover, R., Gutierrez, K. & Repenning, N. (2015) Scalable Game Design: A Strategy to Bring Systemic Computer Science Education to Schools through Game Design and Simulation Creation. *ACM Transactions on Computing Education*. 15 (2), 11:1–11:31.
- Royal Society (2018) *After the reboot: computing education in UK schools*. Available at: <https://royalsociety.org/~media/events/2018/11/computing-education-1-year-on/after-the-reboot-report.pdf>.
- Rüth, M. & Kaspar, K. (2021) Commercial Video Games in School Teaching: Two Mixed Methods Case Studies on Students' Reflection Processes. *Frontiers in Psychology*. 11.
- Ryan, R. M. (1995). Psychological Needs and the Facilitation of Integrative Processes. *Journal of Personality*, 63(3), 397–427.
- Ryan, R.M., Rigby, C.S. & Przybylski, A. (2006) The Motivational Pull of Video Games: A Self-Determination Theory Approach. *Motivation and Emotion*. 30 (4), 344–360.
- Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, 61.
- Ryan, R. M., & Vansteenkiste, M. (2023). Self-Determination Theory: Metatheory, Methods, and Meaning. In R. M. Ryan (Ed.), *The Oxford Handbook of Self-Determination Theory*. Oxford University Press.
- Saeli, M., Perrenet, J., Jochems, W. & Zwaneveld, B. (2011) Teaching Programming in Secondary School: A Pedagogical Content Knowledge Perspective. *Informatics in Education*. 10, 73–88.
- Sentance, S., & Csizmadia, A. (2017). Computing in the curriculum: Challenges and strategies from a teacher's perspective. *Education and Information Technologies*, 22(2), 469–495.
- Sherry, J., Greenberg, B., Lucas, K. & Lachlan, K. (2006) Video game uses and gratifications as predictors of use and game preference. In: *International Journal of Sports Marketing and Sponsorship*. pp. 213–224.
- Shulman, L.S. (1986) Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher*. 15 (2), 4–14.
- Shulman, L.S. (1987) Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational Review*.
- Socratous, C. & Ioannou, A. (2021) Structured or unstructured educational robotics curriculum? A study of debugging in block-based programming. *Educational Technology Research and Development*. 69 (6), 3081–3100.
- Stake, R.E. (2006) *Multiple Case Study Analysis*. Guilford Press.

- Stefaniak, J., Luo, T. & Xu, M. (2021) Fostering pedagogical reasoning and dynamic decision-making practices: a conceptual framework to support learning design in a digital age. *Educational Technology Research and Development*. 69 (4), 2225–2241.
- Ubisoft (2025) *Just Dance 2025 Edition: Nintendo Switch™, PlayStation 5, Xbox Series X|S*. 2025. Available at: <https://www.ubisoft.com/en-gb/game/just-dance/2025>
- Wastiau, P., Kearney, C. & Van den Berghe, W. (2009) *How are digital games used in school? Complete results of the study*. Available at: <http://www.eun.org/resources/detail?publicationID=164>.
- Webb, M. E. (2002). Pedagogical Reasoning: Issues and Solutions for the Teaching and Learning of ICT in *Secondary Schools. Education and Information Technologies*, 7(3), 237–255
- Yadav, A., Gretter, S., Hambrusch, S., & Sands, P. (2016). Expanding computer science education in schools: Understanding teacher experiences and challenges. *Computer Science Education*, 26(4), 235–254
- Yeni, S., Grgurina, N., Hermans, F., Tolboom, J., & Barendsen, E. (2021). Exploring Teachers' PCK for Computational Thinking in Context. *Proceedings of the 16th Workshop in Primary and Secondary Computing Education*, 1–10.
- Yin, R.K. (2015) *Qualitative Research from Start to Finish*. New York, UNITED STATES, Guilford Publications.