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AN INVESTIGATION OF DIGITAL THINKING SKILLS IN EFL DIGITAL INSTRUCTION

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ABSTRACT

Aim/Purpose	The purpose of the current study is to introduce a digital thinking skills (DTS) theoretical model (DTSM) that could support and enhance digital instruction best practices in schools.
Methodology	We have taken a mixed-methods approach. Our respondents represent diverse cultural, linguistic, pedagogical, and social heritages.
Contribution	The study provides a theoretical model developed by Eshet-Alkalai and Aviram that could impact subsequent digital teaching in schools. The highly accessible model may help teachers understand the cognitive learning outcomes that derive from frequently used digital tools.
Findings	We found that teachers do not have a pedagogical concept of digital thinking skills, though many believe such skills might have a positive effect on their learners' achievements. School culture plays a key role in effective DI delivery. Teachers want better in-service IT instruction.
Recommendations for Practitioners	When distance learning has become the order of the day, we recommend practitioners connect pedagogical methodology and disciplinary content with new technology to boost learning outcomes. Recent world events have shown that in many cases practitioners have not been exposed to multiple digital options, especially those that not only present and review learning content but also boost the creation and dissemination of new knowledge.
Recommendations for Researchers	We recommend researchers review different types of available resources and their effective implementation in the school curricula in order to foster creativity and more profound thinking among teachers and learners.

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Impact on Society	Better informed and greatly improved DI in schools is clearly crucial for twenty-first-century systems. As we go to press, in the middle of the coronavirus world-wide lockdown, these words resonate more than ever before. Our research both highlights this obvious need and provides a heuristic bridge between basic research and classrooms.
Future Research	Future studies should focus on a pedagogical digital model that can enhance DI best practices in schools.
Keywords	digital pedagogy, thinking skills, digital innovation, information and communication technology, digital policy, school improvement

INTRODUCTION AND STUDY BACKGROUND

While technology provides many new opportunities for greater enhancement of learning, students do not acquire sufficient abilities in digital competence or working with knowledge (Kiili, 2012; Lundahl et al., 2010). Teachers using digital software in their instruction have continued to teach traditionally. The use of sporadic digital components in classrooms often substitutes for traditional teaching tools (Macaro et al., 2012; Uluyol & Sahin, 2016). In many classrooms, “computer work” has become a source of entertainment or a new form of “busy work” (Cook & Babon, 2017). “Busy work,” which includes simple drilling and gap filling, is a well-known way of keeping learners occupied, quiet, or passive in a classroom. Quizlet is an example of digital “busy work”. Although governments have invested hugely in incorporating technology into schooling and digital teacher education, there is still a distinct need to develop more honed DI. The ‘Learning Compass 2030’ (OECD, 2019) clearly points in this direction.

This study proposes an innovative, flexible, theoretical model, established by Eshet-Alkalai (2004, 2012), as an approach to digital instruction. We investigated whether the Eshet-Alkalai digital theoretical framework, a set of digital thinking skills, could be applied to digital pedagogy, thereby enhancing digital instruction (DI) best practices in schools and closing the perceived gap between the potential of DI and its current use.

Our research was conducted in English as a foreign language (EFL) classrooms in Israel but, based on case-study extrapolation, we deem our findings applicable to other countries and various school subjects.

LITERATURE REVIEW

Many have written about the constraints surrounding digital school instruction. Uluyol and Sahin (2016) highlighted the weaknesses of digital instruction; Hobbs and Tuzel (2017) and Judson (2006) pointed out that teacher attitudes and perceptions often preclude them from integrating technology effectively with instruction. Tigelaar et al. (2004) discussed the shortcomings of digital instruction in schools. Hobbs and Tuzel (2017) remind us that for many teachers “digital learning motivation profiles reveal distinctive identity positions” (p. 20). In a discussion of computer-assisted language learning (CALL), Macaro et al. (2012) found that the enthusiastic take-up of new media by young people was not necessarily accompanied by an understanding of how new media content is produced, nor by a capacity to read it critically, or play a role in the collaborative co-creation of knowledge. Attwell and Hughes (2010) pointed out such shortcomings a decade ago; they are still unaddressed.

We argue that highly complex epistemological and methodological challenges are involved in digital pedagogy and that these are consistently neglected by educators and policy makers.

Recent research into pedagogy that integrates technology for learning, advocates a move toward constructivist approaches (Garreta-Domingo et al., 2017). In order to help students succeed in today’s digital knowledge society, schools should become knowledge-building organizations (Attwell & Hughes, 2010). This suggestion is in line with the idea of learning as knowledge creation (Iiomaki &

Lakkalam, 2018). Moreover, recent research on digital instruction in higher education posits that incorporating technological applications has advanced active learning, furthered learner engagement, and fostered knowledge construction (Seifert, 2012, 2016). Nowadays, technology is the only way to dramatically expand access to knowledge. Digital instruction allows students greater accessibility and variety in knowledge creation (Siemens, 2005).

In the TPACK model, Koehler and Mishra (2008), expounded upon the nature of knowledge required by teachers for integrating technology into the classroom, while addressing the complex, multifaceted and situated nature of teacher knowledge. The TPACK framework extended Shulman's (1987) idea of pedagogical content knowledge.

TPACK calls for a complex interplay of three primary forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK). The TPACK approach goes beyond viewing the three knowledge bases in isolation by emphasizing what lies at the intersections of these primary knowledge forms. This idea is further explained by Koehler and Mishra: "The interaction of these bodies of knowledge, both theoretically and in practice, produces the types of flexible knowledge needed to successfully integrate technology use into teaching" (2008, p. 60).

The step from TPACK to digital learning models seems constructive as regards improving technological pedagogical content knowledge (i.e. the relationship between pedagogical practices, digital instruction, and specific learning objectives). Our research looks in depth at the Eshet-Alkalai model. Other models that delineate effective learning strategies within technology-enhanced learning include the 5C competences model embedded in seamless flipped learning (Lai & Hwang, 2014; Hwang et al. 2015).

THE ESHET-ALKALAI FLEXIBLE DIGITAL THINKING SKILLS MODEL (DTSM)

Eshet-Alkalai and Aviriarn (Eshet-Alkalai, 2004, 2012; Eshet-Alkalai & Aviram, 2006) developed a conceptual framework for digital literacy underpinned by constructivist theories of learning. The model is further discussed in papers by Eshet-Alkalai and Chajut, (2009, 2010). Recent research into digital instruction (Taber, 2016; Kwan & Wong, 2015) continues to highlight the significance of constructivism in digital instruction. A major assumption of constructivism is that individuals learn better when they discover things on their own as a function of their experiences. The design of instruction thus moves away from knowledge dissemination towards knowledge creation. DTSM is essentially based on knowledge frameworks and proposes six theoretical cognitive digital skills.

Photo-visual skills (PVS): Effective photo-visual communication involves the promotion of good visual memory and strong intuitive-associative thinking. Decoding and understanding visual messages easily and fluently is an integral part of new-age learning.

Reproduction skills (RS): With the immense expansion of all boundaries due to digitalism, it has become essential to foster student abilities to create new meanings or interpretations by rearranging and combining preexisting information in any form of media (text, graphic or sound).

Branching skills (BS): The digital world, like the post-modern experience, is messy and nonlinear. Teachers need to grapple with this if they are to upgrade their digital instruction and encourage pupils to think divergently.

Real-time skills (RTS): These involve utilizing the ever-changing digital highway as a more coherent body of knowledge and incorporating it effectively into schools and communities. Knowledge is power.

Skepticism skills (SKS): Digital skepticism demands awareness; students need to evaluate and assess the credibility of digital information in a "brave new world."

Socio-emotional skills (SES): This new assortment of digital skills requires the use of sociological and emotional skills in the personal space of the digital world in order to share emotions and avoid internet traps such as hoaxes and deceptions.

Within this theoretical framework, DTSM offers an accessible model that is helpful to teachers in both choosing digital tools and encouraging skills to foster varied cognitive learning outcomes.

INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) CONTEXT

The study was conducted in Israeli state schools. In the past 20 years, the Israeli government has supported a very expensive digital instruction enterprise (Ministry of Education's Project 'Computer for Each Child'). The budget for purchasing hardware was distributed via local and municipal authorities. Software is often supplied by text-book publishers, most of whom function as competitive, private enterprises. A publisher's textbooks must receive Ministry approval before being used in schools. Teachers also use additional software taken from the internet. In Israel, most classrooms have internet access and overhead projectors; teachers bring their own Ministry-provided laptops to class.

Many education policy makers in Israel view ICT as the sole pedagogical opportunity to improve national scholastic performance. Over the years, Israeli education has leaned strongly towards a traditional reliance on matriculation exams and high-stakes testing at all educational levels. This policy has been strongly criticized by those who view standardized testing as entrenching mechanistic and formal teaching methods, and endangering creativity and higher-order thinking skills. These critics "see in the development of ICT a golden opportunity to create challenging new teaching methods relevant to the pupil's world" (Volansky, 2010, p. 624). Yet, in the actual classroom, there appears to be little knowledge of Volansky and very few changes in pedagogy or learning outcomes.

EFL CONTEXT IN ISRAEL

DTSM seamlessly dovetails with the New Israel National Curriculum (Mazkirut Pedagogit, 2019) for English Language Education, as the curriculum is based on the descriptions of language activities and communicative competences of real life can-do statements delineated in the national curriculum (NC) for English. There is also direct reference to the required integration of ICT in the NC, whereby "learners are provided with tools to competently access, manage, store, create, critically evaluate and use information media and technologies as required" (p. 14).

Our study examined the perceptions and use of ICT in the context of English as a foreign language. English is by far the most important foreign language in Israel and regarded as a gatekeeper to higher education. It plays a powerful role in social mobility, academic recognition, and economic success. English studies mostly commence in Grade Three (ages 8-9) and end with matriculation at age 18.

RESEARCH QUESTIONS

We examined the following four research questions:

1. What are teacher perceptions of the importance of DTS to pupil learning?
2. To what extent do teachers use DTS in their practice?
3. Is there a relationship between the degree of DTS use in the instruction of English as a foreign language and teacher perceptions of the importance of DTS in learning outcomes?
4. Is there a correlation between actual use of DTS and teacher perceptions of the potential of IT to further develop and enhance their school culture?

RESEARCH METHODOLOGY



OBJECTIVES AND RESEARCH APPROACH OF THE STUDY

The study investigates teacher perceptions and use of DTS. A mixed-methods approach (Guba & Lincoln, 1989) was employed. Mixed-methods research, combining the collection and analysis of two different types of data (quantitative and qualitative) illuminates the findings from different points of view, supporting or expressing reservations about them (Johnson et al., 2007).

RESEARCH TOOLS

We employed two methods for the data collection, the semi-structured interviews described below and an online questionnaire, specifically devised for this study and posted on a popular online English teachers network in Israel (www.ETNI.org). The questionnaire examined teacher perceptions and use of Eshet-Alkalai's digital skills (2004, 2012). Table 1 presents the digital thinking skills posited by Eshet-Alkalai with concomitant practical applications and classroom practices in classroom discourse.

Table 1. Descriptions of digital thinking skills with paraphrased classroom discourse

Digital Thinking Skill	Descriptions of examples provided for learning processes/outcomes with DTS
Branching Digital Thinking Skill	Constructing knowledge by using "hypermedia skills," going on Wikipedia journeys using NaraView (e.g. examining extended themes when teaching important concepts).
Reproduction Digital Thinking Skill	Formation of new entities replicating existing elements for enhancing projects and class debates e.g. To-Be Education , Tricider .
Photo Visual Digital Thinking Skill	Interpreting & displaying graphic/visual (not text based) information (e.g. using Imovie , Venngage , storyboard or AR Flashcards for visual representations such as infographics in reading & writing assignments. 
Real-time Digital Thinking Skill	Making use of real-time aspects of digital environments using QR codes ,  Aurasma , Genial.ly for identifying current themes/problems (Team Based Learning).
Skepticism Digital Thinking Skill	Critically evaluating the credibility of digital sources when searching for information for project-based learning (PBL) when using blogs .

To ensure content validity, three pedagogical experts were provided with the table above and asked whether each example was applicable for a specific digital skill. The experts came to a 97% agreement between the paraphrased statements of DTS and the digital tools at hand. Statements that did not receive a high consensus were omitted.

SEMI-STRUCTURED INTERVIEWS

Twenty-five interviews were conducted with four school principals (two elementary, one junior high and one high school; all Hebrew-speakers). We interviewed three advisory teachers, two educated in South Africa and one educated in Moscow, and 18 teachers of English who had participated in an in-service course conducted by one of the authors. They included nine high school teachers from Hebrew medium high schools. Five had immigrated to Israel from the US and the UK, two were educated in Israel, and two were educated in the former Soviet Union. We interviewed four elementary school teachers from Arabic medium schools, all with Arabic as their first language. We interviewed five elementary teachers from Hebrew medium schools: two native speakers of Hebrew, one native speaker of Russian and one native speaker of Spanish. Experts examined and validated the interview questions and reached consensus about them with the researchers (Appendix A).

DATA COLLECTION

The researchers had developed a long-standing trust with the participating principals, coordinators, and teachers. Interviews were recorded and transcribed. An online database was created to store and encode interviews. Responses were coded according to identified categories (iterative review). Code frequencies were later manually highlighted and subsequently categorized into themes.

Interviews were generally conducted in schools. Nearly all participants were very keen to share their experiences, dilemmas, and involvement in instruction using IT with the researchers. Interview responses were analyzed using the reiterative review and sorting of identified topics and notions, using color coding in the raw data. The two open-ended questions were similarly analyzed. Closed questions were statistically analyzed using SPSS software.

ONLINE QUESTIONNAIRE

There were 64 respondents: 68% were high school (HS) teachers (10th-12th grades), 22.5 % taught in junior high (JH) schools (7th-9th) and 9.5% in elementary schools (4th-6th grades); 30% were English teachers and department heads. Advisory teachers for English and IT advisory teachers accounted for 5% of respondents; 67% had participated in IT in-service training. There was no significant difference in the average teaching tenure by grade levels taught. The overall mean teaching tenure was 19 years ($M = 19$) with a wide SD ($= 10.63$), and the median was 17.5 years.

A first name only online questionnaire was widely distributed, using email recruitment, social media, and snowball sampling during a three-month period. It was posted on a site frequently visited by teachers of English in Israel and also on the English Teachers' Facebook site. A detailed explanation of the questionnaire is included in Appendix B. The questionnaire relates to a teacher's professional background (teaching tenure, participation in IT in-service training, and perception and use of IT as part of the IT culture).

1. Professional background of teachers:
 - a) Teaching tenure as defined by the number of years teaching.
 - b) Participation in IT in-service training: 0=no, 1=yes.
 - c) Perception of IT school culture was measured by one item where teachers rated the extent to which IT is part of their local school culture from 1 to 5.
 - d) A teacher's general perceptions of ICT was measured by five items on a five-point scale ranging from 1=strongly disagree to 5=strongly agree. The items related to teacher perceptions of how much IT contributes to pupil learning. Samples of questions is included in Appendix C. An index was calculated as the mean response to items, with Cronbach reliability coefficient .734.
2. Teacher perceptions that IT can develop DTS were examined using five items from DTSM, each of which referred to a different DTS. Responses to statements were on a five-point scale

from 1=strongly disagree to 5=strongly agree. An index was composed for this item with Cronbach's alpha (reliability) = 0.813. Samples of statements are included in Appendix C.

- Teacher use of DTS (i.e. practice) in the classroom was measured indirectly by five items relating to the extent of pupil application of each of the five digital skills. Each item was accompanied by a five-point scale from 1= they cannot do this, to 5=they can do this very well. An overall use index was calculated that had a Cronbach's alpha reliability coefficient of .803. In order for teachers to understand the concepts of digital thinking skills, examples were provided for each digital skill. Samples are included in Appendix C.

ETHICAL CONSIDERATIONS

It was made clear to all participating principals, coordinators, and teachers that data was for research purposes only. In addition, participants were assured that their names and those of the schools would be eliminated from research files.

FINDINGS

In order to provide a unified picture, quantitative findings are first presented and thereafter reinforced by qualitative findings. The findings related to our first research question are below:

What are teacher perceptions regarding the importance of DTS to pupil learning?

We conducted an analysis of variance with repeated measures followed by a Bonferroni test. The findings reveal differences ($F(4,27) = 6.25; p < .001$). The source of these differences is in Realtime> Skepticism. Means are presented in Figure 1.

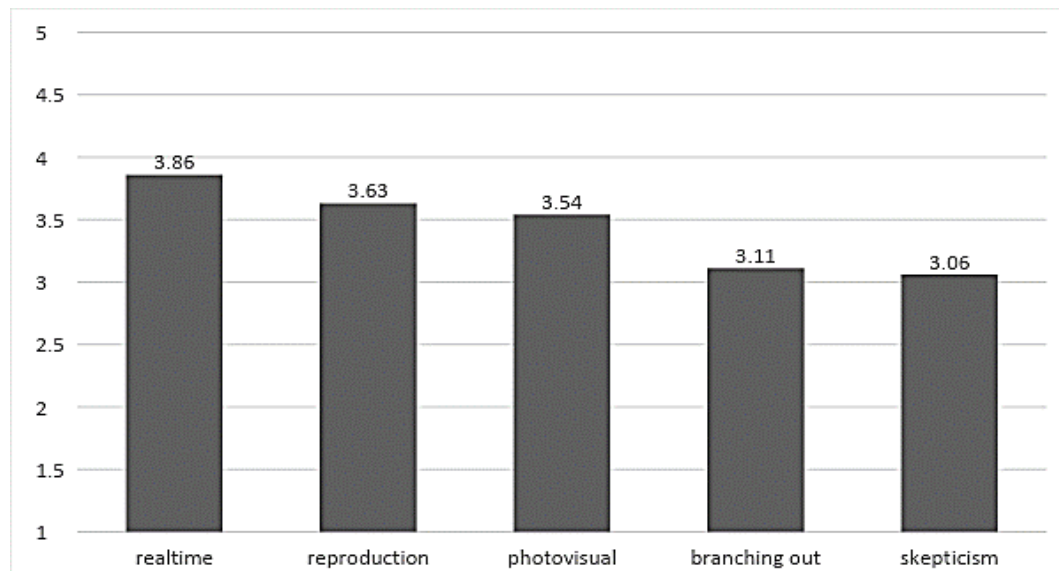


Figure 1. Teacher perceptions of IT ability to develop DTS

As can be seen from the Figure 1, in the opinion of teachers, all DTS skills can be developed to a moderate degree (> 3 and < 4 on a Likert scale 1-5). Realtime ($M=3.86$), Reproduction ($M=3.63$), Photovisual ($M=3.54$), Branching out ($M=3.11$) and Skepticism ($M= 3.06$). These findings are reinforced by the qualitative data.

Teachers also expressed a positive attitude towards the importance of digital thinking skills in their pedagogy. T1 claimed:

Digital thinking skills could be excellent.

However, she was not alone when bringing up her need for better preparation for IT instruction, adding:

...but teachers need a lot of training, and interactive programs need to be developed, particularly in subjects like English.

She was specific in mentioning that:

We must find better ways to incorporate a digital platform into our daily lesson plans.

In her late 30s and with five years of experience in high school teaching, she states that she loves using technology in the classroom for many reasons:

It increases interest, creates excitement, and improves thinking skills. My students love learning this way. They are engaged on a multi-sensory level. It keeps them focused and they get to work right away. A lot of learning can take place. Sometimes my pupils think of clever things. Joe in Grade 10 is conducting digital research into his Jewish ancestors. He has made a website with links to a variety of sources he selected himself.

Below are our findings relating to our second research question:

To what extent do teachers use DTS in their practice?

We conducted an analysis of variance with repeated measures, followed by a Bonferroni test of the five relevant items. The findings reveal differences in perception ($F(4,48) = 8.89$; $p < .001$). The source of these differences is $RS >$ all digital thinking skills. The means are presented in Figure 2.

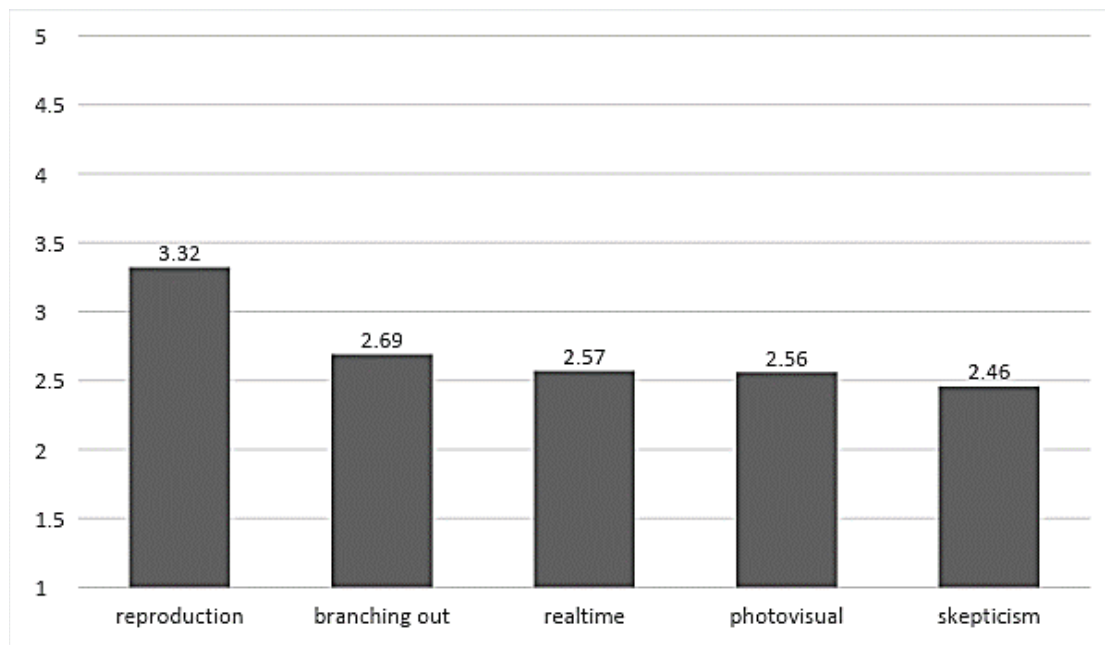


Figure 2. Teacher perceptions regarding pupil use of DTS in their classes

As seen in Figure 2, teachers reported moderate to little use of all DTS by pupils. RS is used markedly more than any other skill ($M=3.32$), and the skepticism skill is applied the least often ($M=2.46$).

In the interviews, 15 out of 17 teachers reported that they had been using IT in the past five years. Teachers focused most on reproduction skills and least on digital skepticism. T2 reported:

At the end of each unit, students were requested to present a summary of what they had learnt using a different medium such as Powtoon, and Goanimate. Students were really excited about this assignment.

She regretfully adds:

My students believe what they see and often just cut and paste. They do not ask questions as to reliability, credibility or even the quality of their sources.

She claimed that teachers were uncomfortable applying the Skepticism DTS, and were unsure of how to guide their students to search for reliable online sources: She explained:

I'm a bit worried ... pupils are often requested to search for sources on the internet and I find it difficult to explain what a credible online source is. And anyway, I work in a religious school and we have a more closed internet system so the reliability of sources really is problematic.

Our third research question asked:

Is there a relationship between the degree of DTS use in the instruction of English as a foreign language and teacher perceptions of the importance of DTS in their pupils' learning outcomes?

Below are our findings. A t-test (paired) was conducted in order to check the differences between these variables. The results are shown in Figure 3.

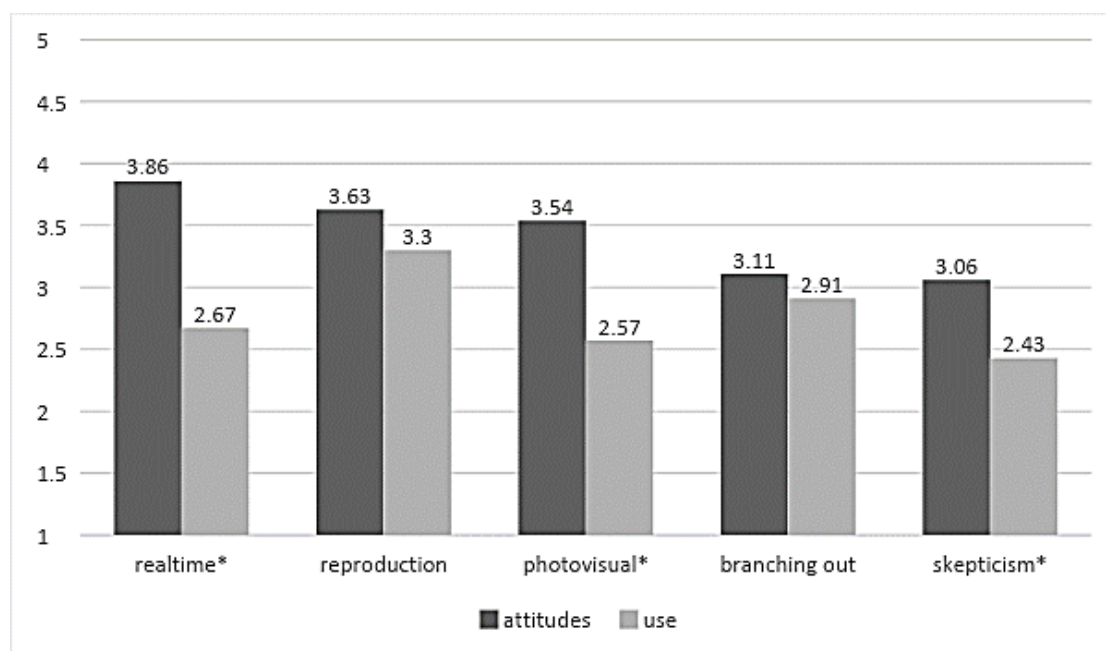


Figure 3. Differences between attitudes towards IT use of DTS and classroom use of DTS
*Significant differences $p < .001$

Figure 3 illustrates that the use of DTS in the classroom as reported by teachers is consistently lower than their perceptions that DTS could be developed through IT.

We found no significant differences between perceptions and reported use with regard to RS and BS; however, we did find differences when it came to RTS, PVS, and Skepticism.

Teachers added further perspectives on perceptions and classroom practices. T3 elucidated:

There is huge potential in DTS to make digital learning far more relevant for our students...

Your questions made me think about the difference between using the computer as a text book extension and the potential of digital thinking.

Interestingly, she affirms:

...but we teachers need to be taught the connection between pedagogy and the specific learning outcome we are interested in when using digital tools. So, I suppose, eventually, learning outcomes will change, too.

Our fourth question was:

Is there a correlation between actual use of DTS and teacher perceptions of the potential of IT to further develop and enhance their school culture?

Here we looked at the extent to which teacher use of DTS related to their perceptions regarding the potential of IT to develop their school IT culture and their participation in IT in-service training. Table 2 presents correlations between the various variables.

Table 2. Correlations between use of DTS and other variables

Variable	Correlation with use index
Teacher perceptions in IT development of DTS	.374**
Overall attitudes towards IT	.508***
Teaching tenure	-.254
In-service training	.225
IT in school culture	.312*

* Correlation is significant at the 0.05 level

** Correlation is significant at the 0.01 level

*** Correlation is significant at the 0.001 level

As seen in Table 2, three variables significantly and positively correlate with the use index: teachers' overall attitudes towards IT, teacher perceptions regarding the IT development of DTS, and IT in the school culture. Teaching tenure and previous participation in IT in-service training were not statistically correlated with use.

Multiple regression analysis was conducted with three independent variables which were significantly correlated with the dependent variable-use index: teacher perceptions of IT to develop DTS, IT in their school culture, and their tenure. The results were statistically significant ($F=4.758$, $p=.006$) and 23.7% of the variance in the use index explained. As seen in Table 3, all three independent variables were significant (or near significant in the case of tenure). Accordingly, the greater the IT school culture, the greater the teacher's perception of IT use for DTS; the lower the teacher's tenure, the more likely they will be using DTS in the classroom.

Table 3. Multiple regression results for predicting the use index

<i>Independent variable</i>	<i>Beta</i>	<i>SE</i>	<i>P</i>
IT school culture	.278	.108	.041
Tenure	-.239	.011	.072
Teacher perceptions of IT for DTS	.294	.148	.031

The findings show three significant variables in the use index: IT school culture, tenure, and teacher perceptions of IT for DTS.

The importance of the IT school culture was a recurring theme in the questionnaire, open questions, and interviews. T3 encapsulated this idea, stating:

If principals were on top of IT there would be more knowledge, more guidance, and better-quality IT in-service. Workshops would improve... Our IT in-service meetings are a bit dull. So twentieth century!! There is no space in which we talk about critical thinking or developing out-of-the-box ideas. We mainly gripe about faulty infrastructure. Sometimes we learn to use new closed programs and apps such as Mentimeter, Flipgrid, Gimkit, and Ed-puzzle.

DISCUSSION

This paper centers on an adaptation of the DTSM of Eshet-Alkalai. Other models could also be rendered into pedagogical outcomes, such as Hwang and Wang's 5 C model (Lai & Hwang, 2014; Hwang et al., 2015), which offers pedagogical adaptations to a theoretical model. Many scholars have observed that teacher attitudes and perceptions often prevent them from moving forward and accepting change in their practice (Judson, 2006). Our research strongly echoed the literature in this respect. Resistance to change is deeply ingrained in the teaching profession.

As we have noted, Seifert (2012; 2016) observed that recent research into addressing digital instruction in higher education posits that the incorporation of technological applications advances active learning, furthers learner engagement, and fosters knowledge construction. Siemens (2005) strongly advocates technology as the only way to dramatically expand access to knowledge. Digital instruction allows students greater accessibility and variety in knowledge creation. Our research points out that school instruction still lags behind in fostering knowledge construction and discovery-based learning.

In our case, the respondent reactions to the questionnaire testified that formulaic concepts have the potential to foster DTS which encourages superior learning outcomes, creativity, and innovation. For all that, the Eshet-Alkalai model is easily accessible, simple and clear, but not all teachers saw its immediate practical pedagogical implications. Further scaffolding, expansion, and exemplification within the model would assist teachers; additionally, more INSET and a new kind of conversation are needed regarding classroom development of digital thinking skills. Current research reports that digital instruction requires different pedagogical knowledge in order to attain new educational goals (Rossi & Mustaro, 2015).

School culture is a determining factor in school climate, so School Principal 1's words were not surprising:

It's all about exams. Projects and stuff like that are wonderful, but while high stakes test results count for so much ... forget it... They will research later in life ... or not!

Our study was based in a single country, characterized by a specific culture of education, technology, and its implementation in schools. It would be interesting to explore how DTSM could work in different educational settings. Although our questionnaire was posted onto a national site, there was a disproportionate reply rate from teachers of junior high and high schools; far fewer elementary school English teachers responded. It would be significant to include their views.

It is clear that educational changes are necessary in three obvious settings: (a) practice (classrooms), (b) in-service programs (INSET), and (c) within school goals. These are also known as school visions or principals' objectives. The strength of the model lies in addressing these gaps.

This study raises important questions. First, how do we best rethink classroom practice in order to enhance digital thinking? INSET, always a convoluted endeavor, also requires careful planning and

restructuring if it is to provide teachers with the critical twenty-first-century skills that they are demanding. Last but not least, is it possible to establish goals that promote critical thinking, creativity, and autonomous learning while standardized testing directs school leadership?

CONCLUSIONS

Although our data indicate an overall enthusiasm for using IT in class, our findings strongly suggest that there is still a need to deepen the teacher conversation regarding DTS in the class. Teachers appear to understand the difference between using technology “because it exists” and really making the most of new-age technology to foster creativity, thinking, innovation, and understanding among pupils. Analyses of teacher replies (digital skeptical skills) point, nonetheless, to a ubiquitous frisson of fear of digital usage: Are sources reliable? Are we exposing our students to subversive knowledge? Will all this technology work in my class on Monday morning?

Our research explored whether there is a relationship between the degree of classroom application of digital thinking skills in the instruction of EFL (= Use index) and teacher positions regarding the importance of these skills in improving teaching/learning a language (= Perceptions). The most prominent concern here is the differences between teacher perceptions of importance and perceptions of use in the Realtime, Photo-Visual, & Skepticism DTS.

It is clear from both the qualitative and quantitative findings that DI has changed the way students carry out assignments. Student production skills are highly developed and appear to be getting better. Paradoxically, teachers are behind their students in their knowledge of digital production potential. Some teachers ruefully blamed their in-service provision for this digital gap.

The findings indicate that the merit of DTS is the added value of digital instruction to dramatically expand access to knowledge, the capacity to read critically, and contribute to the collaborative co-creation of knowledge. Teachers are dealing with innovative, exciting teaching modes in technology but are not yet making full use of their potential. We are often in a paradoxical situation, one which has become a new norm, where students are more capable than their teachers in using and recognizing the potential of the digital world. Even teachers who are aware of the potential of new-age technology to foster creativity, thinking, innovation, and understanding among pupils still only use IT “because it exists.” Such teachers are at a loss as to how to initiate required changes. Could DTSM be the trigger for change? Could this be the match that ignites the bonfire?

Especially in light of the COVID-19 crisis, new technologies provide unprecedented opportunities for knowledge creation. Now and in the foreseeable future, technology can support new pedagogies which focus on learners as active, critical participants with tools for inquiry-based learning. It is incumbent upon us to re-evaluate how, why, and when we use technology in our schools, what we need to do in order to bring our schools rapidly up to speed, what the budget is, and who is responsible for establishing clear goals and objectives. It is at this interface – where government, local authorities, and school management converge – that decisions are either made or obfuscated.

Clearly, two steps must be urgently taken by leadership and policy makers to upgrade digital instruction and allow its potential to come to the forefront: the improvement of the in-service teacher conversation within the in-service framework, and the identification of productive and creative IT assisted learning outcomes. It is to our own peril if we do not “rise up and live out the true meaning” of technology in the classroom. We need to uncover, address, and close digital gaps.

We believe Eshet-Alkelais’ formulaic digital thinking skills contribute to the ongoing conversation about expanding digital use into the domain of critical thinking and creative skills. Our research suggests we are only at the start of a paradigm shift.

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The participation in this research was anonymous. The study was approved in compliance with ethical standards and the conflict of interest specifications of David Yellin College and the Jerusalem Institutional Ethics Committee. The authors declare that they have no conflict of interest.

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APPENDIX A: SAMPLE QUESTIONS

- Can you describe the kind of support teachers receive in digital instruction?
- Can you tell us how digital instruction has changed teaching in your school?
- Can you list ways in which you use digital tools to foster cognitive learning processes?
- Do the following digital tools (Table 1) foster knowledge construction?
- Do your pupils construct new knowledge (learning outcomes) when they use the following digital tools (Table1)?
- Do you believe there is a connection between a pupil's ability to construct new knowledge and produce learning outcomes when using a specific digital tool?

APPENDIX B: ONLINE QUESTIONNAIRE

<https://docs.google.com/forms/d/145xB9MouAwzEsKu9yKL5NSNJ1ytFoZMI1CdQAAWYMWo/edit>

IT Lessons in the EFL Classrooms in Israel

Dear Colleague,

We know how busy teachers are and we appreciate your valuable time and assistance.

We are currently conducting research into digital instruction and we'd like to ask you a few questions about IT (Information Technology) teaching in your English classes. The purpose of our research is to develop pedagogical methodology in this area. As you know, Information Technology (IT) is the use of any computers, storage, networking and other physical devices, infrastructure and processes to create, process, store, secure and exchange all forms of electronic data.

Filling out and sending back this questionnaire will help us enormously. The data will be collected only for the purpose of this research. Your participation or continued participation is voluntary and you may ask at any time to cancel your participation. The questionnaire is anonymous and will take you approximately 10 minutes to complete.

Thank you for your help,
Tamar and Shai

Personal information

1. Which grade levels do you teach?

☐ 4th - 6th

☐ 7th - 9th

☐ 10th -12th

☐ אחר:

2. What role do you currently hold at school?

☐ English teacher

☐ Technology consultant

☐ English teacher & Tech Consultant

☐ Coordinator of English

☐ אחר:

3. How many years have you been teaching

4. How many years have you been a technology consultant?

5. Have you attended IT specific Inservice training (השתלמויות)?

- ☐ Pisga
☐ School
☐ Other
☐ None

6. Is your school involved in the "Digital Schools Project"?

- ☐ Yes
☐ No
☐ Don't Know

7. If yes, how many years have you taken part in the "Digital Schools Project"?

- ☐ One year
☐ Two years
☐ אחר:

8. To what extent is IT part of your school culture?

1 2 3 4 5

the lowest level ☐ ☐ ☐ ☐ ☐ the highest level

9. How many times a week do you involve technology in your lessons?

- ☐ once
☐ twice
☐ three
☐ four
☐ more than four
☐ אחר:

10. What percentage of the pupils' homework or external tasks include technology?

	0%	25%	50%	75%	100%
estimated percentage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. During your (the teacher's) digital instruction, what percentage of your students actually use technology, on task, in class time ?

	0%	25%	50%	75%	100%
estimated percentage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. Do you think IT lessons improve creativity?

1 2 3 4 5

Do not improve ☐ ☐ ☐ ☐ ☐ Improve to a great extent

13. There is a connection between using IT and the improvement of learner achievements in English as a Foreign Language.

1 2 3 4 5

strongly disagree ☐ ☐ ☐ ☐ ☐ strongly agree

14. To what extent are you pleased with the use of IT in your English Teaching?

1 2 3 4 5

very low ☐ ☐ ☐ ☐ ☐ very high

15. To what extent do you think that limited knowledge of English causes frustration in coping with tasks in a digital lesson

1 2 3 4 5

experience little frustration ☐ ☐ ☐ ☐ ☐ experience considerable frustration

16. Integration of technology in English Instruction

To what extent do your pupils apply the following digital skills in their learning? 1- can not do this, to 5 - can do this to a very good extent

	1	2	3	4	5
1. the construction of knowledge in multiple ways (e.g., using software for concept maps, mind mapping, diagrams).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. within the Domain of Appreciation of Literature: to construct knowledge by using "hypermedia skills" (e.g., teaching literature by entering links & using several sources of digital input.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. within the Domain of Presentation: to creatively reproduce learning outcomes using a variety of digital media (e.g., filming posters, videos of class debates when presenting projects)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. within the Domain of Access to Information: to interpret digital graphic/visual representations/icons (not text based) that allow pupils to comprehend & interact with a theme (e.g., interpreting visual representations such as Infographics, emoticons, 'Emoji' icons in writing tasks.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. within the Domain of Access to Information: to make use of the real time aspect of digital environments as a trigger for identifying theme/problem (e.g., QR Code, forums..)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. within the Domain of Access to Information: to critically evaluate the credibility of digital sources when searching for information in order to construct new knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. Which one of the above digital skills do your pupils apply the most in their learning?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6

18. Which one of the above digital skills do your pupils apply the least in their learning?

- ☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6

19. Please express your opinion regarding the following statements:

1 -strongly disagree to 5- strongly agree

	1	2	3	4	5	I don't know
1. There is a connection between pupil ability to digitally access information in a non linear disordered manner and pupils' knowledge construction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. There is a connection between IT instruction and pupil ability to construct multiple ways of understanding information (e.g., mind mapping)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. There is a connection between IT instruction and student engagement with real-time websites (e.g., news/general content, such as Ynet, Walla, others) that are relevant to subject being studied.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. There is a connection between using IT instruction and pupil ability to create new meanings/interpretations of existing materials in any form of digital media (text, graphic, sound).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. There is a connection between using IT instruction and pupil ability to integrate a variety of digital visual cues/prompts into the learning process (e.g., pictures, icons, films).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6.. There is a connection between IT instruction and pupil ability to critically evaluate the credibility of digital information.

☐ ☐ ☐ ☐ ☐ ☐

20. Which one of the above statements do you agree the most ?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6

21. Which one of the above statements do you agree the least?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6

22. Please indicate to what extent do you agree or disagree:

1 - strongly disagree to 5- strongly agree

	1	2	3	4	5
1 Digital media empower pupils towards divergent thinking .	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. In IT lessons, pupils are exposed to a language-rich environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. In IT lessons, pupils are merely exposed to a variety of sites with verbal stimuli (e.g., Starfall).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

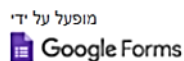
23. Please note your own thoughts about digital teaching

24. Please tell us about your personal choices/decisions in digital instruction?

Thank you so much!



Google Forms לעולם אל תשלח סיסמאות באמצעות



Google. תוכן זה לא נוצר ולא נתמך על ידי
דווח על שימוש לרעה - תנאים והגבלות - מונחים נוספים

APPENDIX C: TEACHER PERCEPTIONS

Perceptions of IT as contributing to pupil learning – sample questions:

- To what extent is there a connection between using IT and the improvement of learner achievement?
- To what extent are you pleased with the use of IT in your English classes?
- To what extent do IT lessons empower pupils towards divergent thinking?
- To what extent do IT lessons foster construction of knowledge in multiple ways?
- To what extent are learners exposed to a language-rich environment in IT lessons?
- Do IT lessons improve creativity?

Teacher perceptions about whether IT can develop DTS – sample teacher statements:

- There is a connection between IT instruction and pupils' ability to digitally access information in a nonlinear disordered manner and pupils' knowledge (e.g. NaraView)
- There is a connection between IT instruction and pupils' ability to construct multiple ways of understanding (e.g. mind mapping).
- There is a connection between IT instruction and pupils' engagement with real-time websites to foster knowledge construction (e.g. Augmented Reality software, HP reveal, digital news).
- There is a connection between IT instruction and pupils' ability to integrate a variety of digital cues/visual representations into the learning process (e.g. Infographic).
- There is a connection between IT instruction and pupils' ability to create new meanings/new learning outcomes of existing materials in any form of digital platforms in inquiry-based pedagogies (e.g. Itimelapsepro & Imovie for filming videos foster project-based and inquiry-based learning).
- There is a connection between using IT instruction and pupils' ability to critically evaluate the credibility of digital information (e.g. Blogs & Forums).

Explanation and exemplification of digital learning skills –examples:

- To what extent do your pupils apply the following digital skill in the construction of knowledge in multiple ways (e.g. creating concept maps, mind mapping in Mindmeister, Mindmup)?
- To what extent do your pupils apply the following digital skills to construct knowledge using hypermedia skills (e.g. teaching literature by going on Wikipedia journeys using nonlinear sources of digital input such as in “NaraView”)?
- To what extent do your pupils construct knowledge by creatively reproducing learning outcomes using a variety of digital media (e.g. using “Imovie” to film videos when presenting project-based and inquiry-based learning or software for simulations in role playing)?
- To what extent do your pupils construct knowledge by interpreting digital graphic/visual representations/icons (not text-based) that allow pupils to comprehend and interact with a theme (e.g. interpreting visual representations such as in “Venngage, Infogr.am” using Infographics, emoticons, in writing tasks)?
- To what extent do your pupils construct knowledge by making use of the real time aspect of digital environments as a trigger for identifying theme/problem (e.g. digital news such as Ynet, QR Codes and Augmented Reality software “HP reveal”, “Cospace”)?
- To what extent do your pupils construct knowledge by critically evaluating the credibility of digital sources (blogs, forums) when searching for information in order to construct new knowledge?

BIOGRAPHIES



Dr Tamar Meirovitz is a lecturer and teacher educator at Beit Berl College. She has developed English Teaching Certification Programs and served as institutional coordinator at the David Yellin College in the international Erasmus+ (CURE) Curriculum Reform Project. Tamar was nominated as regional consultant for TEFL for the Israel Ministry of Education. Her interests are mentorship and dilemmas in teacher education, educational leadership and digital instruction.



Dr Shai Aran served as Ministry of Education Inspector for English and teacher educator at David Yellin Academic College of Education, Jerusalem, until her retirement. She currently teaches English in a pre-academic setting at the Hebrew University of Jerusalem. She has written published textbooks. Her interests are her family, school improvement, her students, cycling and pop music.