EÖTVÖS LORÁND UNIVERSITY
FACULTY OF PEDAGOGY AND PSYCHOLOGY

DOCTORAL SCHOOL OF EDUCATION

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NURTURING CREATIVITY IN TECHNOLOGY-ENHANCED LEARNING ENVIRONMENTS: A QUALITATIVE MULTIMETHOD STUDY OF TEACHERS' BELIEFS AND PRACTICES

DOCTORAL (PhD) DISSERTATION

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Dedication

This work is dedicated to the memory of my father, Sándor Bereczki, who passed away during the pursuit of this dissertation. He always encouraged me to fulfil my highest potential and inspired me to become my most creative self. For this, and so much more, I will always feel a depth of gratitude and immense blessings.

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Chapter 1: Introduction

This introductory chapter outlines the rationale and background of the current study by addressing gaps within the previous literature (Section 1.1), states the purpose of the research and poses research questions (Section 1.2), and clarifies its significance (Section 1.3). This chapter ends with an outline of the dissertation (Section 1.4).

1.1 BACKGROUND AND RATIONALE

> 'We hear much these days about the remarkable new thinking machines. We are told that these machines can be made to take over much of men's thinking and that the routine thinking of many industries will eventually be done without the employment of human brains. […] Eventually about the only economic value of brains left would be in the creative thinking of which they are capable' (Guilford, 1950, p. 445)

In the past 25 years, creativity has increasingly been recognised as an important aspect of young people's education around the world (Craft, 2005). The global interest in fostering students' creative capacities has been fuelled by its potential to address the economic, social, and global challenges posed by the twenty-first century knowledge-based society (Beghetto, 2010; Shaheen, 2010). Evidence for the growing emphasis on creativity in education can be provided by its inclusion into various curricular documents around the globe, for example, in Australia, China, Hong Kong, Taiwan, Singapore, the USA, and the UK (Hui & Lau, 2010; Shaheen, 2010; Wyse & Ferrari, 2014). Heilmann and Korte (2010) recorded no country in the European Union (EU) the curriculum of which would not highlight to a certain extent the significance of creativity in mainstream education. At the EU level, creativity has been recognised as a transversal aspect of all key competences for lifelong learning (European Parliament and the Council, 2006). Creativity is an important goal of public education in Hungary too, and is included in the Hungarian National Core Curriculum (HNCC) as relevant for all domains and age groups (Bereczki, 2016; HNCC, 2012).

In addition to creativity, technology is also an important aspect of today's classrooms. To be effective in the knowledge society, students are required to create,

evaluate and use information, media, and technology (Molnár & Kárpáti, 2012). Several researchers have highlighted that digital technology can make a distinctive contribution to the development of creativity in education by providing new tools, media, and environments for learning to be creative and learning through being creative (Glăveanu, Ness, Wasson, & Lubart, 2019; Loveless 2003; 2007; Lubart, 2005; Nikolopoulu, 2015; Mishra et al., 2013). The view that technology can promote creativity and learning is also shared by educators across many countries (Cachia & Ferrari, 2010).

Research on the use of educational technology has shown that digital tools alone do not make learning more effective (Luckin at al., 2012). Similarly, technology-enhanced creativity development can only be effective, if teachers can make informed choices of how and when to use technology, building on their knowledge about both the specific features of digital tools and the characteristics of creativity. Though a range of theoretical works have emphasised the potential of digital technologies for supporting creativity in the classroom, only few investigated the effects of technology-enhanced learning interventions on students' creativity (Lai, Yarbro, DiCerbo, & de Geest, 2018; Ma, 2006; Scott, Leritz, & Mumford, 2004a, 2004b). Research on technology-supported creativity-enhancement suggests that creativity can be developed using digital tools, findings of experimental studies, however, do not appear to have direct relevance for primary and secondary education (Lai et al., 2018). Thus, more research is needed with themes and questions grounded in the realities of classroom practice.

Creativity researchers generally agree that the beliefs teachers hold about creativity shape the ways in which they engage in the promotion of students' creative capacities in the classroom (Andiliou & Murphy, 2010; Beghetto, 2010; Skiba, Tan, Sternberg, & Grigorenko, 2017). Existing research investigating teachers' beliefs about creativity has produced valuable findings on how teachers conceptualize creativity, their views about the profile of creative students and teachers, as well as their perspectives on creativity-fostering learning environments. Earlier findings on the topic were synthesized by Andiliou and Murphy (2010), indicating that teachers' beliefs have often been found at variance with research-based perspectives. Little is known, nevertheless, about what views teachers hold about creativity in recent years, and especially about its promotion through technology.

Also, literature on teachers' beliefs suggests that highly accomplished teachers conceptualize creativity consistent with the literature, and have a rich repertoire of

teaching strategies to promote creativity in the classroom (Henriksen & Mishra, 2015; Merriman, 2015; Scott, 2015), and therefore, might play an important role in promoting research grounded beliefs among educational stakeholders as well as inform future studies to pursue themes relevant for the classroom. Their views on creativity, technology, and learning, however, have not been explored yet.

Finally, several studies examined Hungarian teachers' beliefs and pedagogical experience in diverse areas such teaching, learning, students, and school environment (e.g. Falus, Golnhofer, Kotschy, Nádasdi, & Szokolszky 1989; Golnhofer & Nahalka, 2011; Hercz, 2005; Vámos, 2001), standardized student assessment (Tóth, 2011), specific teaching practices (e.g. Tóth, 2008), integration and diversity (e.g. Bereczky & Fejes, 2010; Nagy, 2002), and technology integration (e.g. Buda, 2010; Kis-Tóth, Borbás, & Kárpáti, 2014), yet, to our knowledge, educators' views about creativity and its nurture, and specifically through the use of technology, have not been investigated in the Hungarian context.

1.2 PURPOSES AND RESEARCH QUESTIONS

The purpose of the study described in the present dissertation was then to explore teachers' beliefs about and experience with nurturing student creativity in technology-integrated learning environments to generate themes and questions for future research on creativity, learning, and technology grounded in the realities of the classroom as well as to support policy, teacher education, and practice in the area of technology-enhanced creativity education. The overarching research questions guiding this study were the following:

> *What characterizes teachers' beliefs about and experience with nurturing creativity using educational technology?*
>
> *How do teaches' beliefs and experience relate to the existing empirical evidence on creativity, learning, and technology?*

The study was conducted in the pragmatic paradigm and applied a qualitatively-driven multimethod approach combining a systematic literature review (Study 1) and multiple case studies (Study 2).

The purpose of Study 1 was to describe, appraise, and synthesize the most rigorously available current empirical research base on in-service K-12 teachers' beliefs about creativity and its nurture, with special focus to the perceived roles of technology in fostering creativity. Study 1 sought to answer the following research questions:

Q1: What is known about teachers' recent beliefs about creativity?

Q2: What is known about teachers' beliefs with regard to nurturing creativity with technology?

Q3: What is known about the relationship between teachers' creativity beliefs and classroom practices?

Study 1 applied a systematic literature review approach to answer the research questions and drew data from a systematically identified empirical evidence base consisting of 53 studies published between 2010-2015 on teachers' beliefs about creativity and its nurture.

The purpose of Study 2 was to investigate the relationships between learning, creativity, and technology by exploring Hungarian digital pedagogy expert teachers' beliefs about and experience of nurturing creativity in technology-enhanced learning environments across six areas of the secondary school curriculum: arts, EFL, Hungarian language and literature, mathematics, science and social studies.

Study 2 sought to answer the following research questions:

Q1: What characterizes Hungarian digital pedagogy expert secondary school teachers' beliefs about creativity?

Q2: What characterizes Hungarian digital pedagogy expert secondary school teachers' beliefs about nurturing creativity with technology in their subject areas?

Q3: What enablers and barriers do Hungarian secondary digital pedagogy expert school teachers perceive to stimulating students' creativity with technology?

Q4: What characterizes Hungarian digital pedagogy expert secondary school teachers' enactment of their beliefs about nurturing creativity with technology in the classroom?

Study 2 applied multiple case study design to answer the research questions, involved 12 digital pedagogy expert teachers identified through purposeful sampling, and collected

data using interviews, classroom observations, document, and image analysis.

1.3 SIGNIFICANCE OF THE STUDY

Answering the research questions of the current study is expected to refine and enhance the educational context in terms of fostering creativity, and specifically in terms of fostering it with technology. The prospective significance of this study can be classified into four domains, namely educational research, policy, teacher education, and practice.

The study is significant in terms of educational research because:

- It fills the research gap in the body of knowledge on teachers' beliefs about and experience with nurturing creativity in technology-enhanced learning environments.
- It provides future research on the relationships among creativity, learning, and technology with themes and research question grounded in the realities of the classroom.

The study is significant in terms of educational policy because:

- It can inform educational policymakers about pedagogical beliefs and practices of nurturing creativity, and specifically of nurturing it with technology. Policymakers can benefit from these findings when revising policies to promote creativity in education.
- It can aid policymakers to address contextual constrains and challenges to fostering creativity in education. Policymakers could use the list of constraining and facilitating factors identified through the research to support the creation of classroom contexts conducive to students' creative development.

The study is significant in terms of teacher education because:

- It provides an evidence base of what teachers believe about creativity and its nurture with technology in the current literature as well as offers a detailed account of Hungarian digital pedagogy expert secondary school teachers' beliefs and practices with respect to technology-enhanced creativity development. Teacher education can build upon the findings of the current study and determine how the beliefs synthetized and explored in this study relate to pre-service and in-service professional development programmes.

- It identifies factors that facilitate or limit teachers to translate their intentions and abilities to foster creativity with technology in the classroom. These factors can be introduced to teacher education to help teachers develop strategies to cope with limitations and leverage supports.

The study is significant in terms of practice because:

- It provides teachers with an overview of creativity research to inform beliefs and practices of nurturing creativity with technology, which could help them develop more effective creativity-fostering classroom practices.

The significance of this study is discussed in more detail in Chapter 6, where implications, contributions, and suggestions for future research are presented based on the findings, and their interpretations.

1.4 OUTLINE OF THE DISSERTATION

The first three chapters of the dissertation set the scene for the research. Chapter 1 presented the background and need for the current study, described it purposes and research questions, and clarified the significance of the research.

Chapter 2 contains the review of the related literature in four areas: creativity, nurturing creativity in education, the role of technology in nurturing creativity, and teachers' beliefs and practices of nurturing creativity in technology-enhanced learning environments.

Chapter 3 explains the rationale and methodology for conducting a qualitatively-driven sequential multimethod research in the pragmatist paradigm.

Chapter 4 presents Study 1 of the a qualitatively-driven sequential multimethod research. The chapter first discusses the systematic literature review methodology applied to answer the sub-questions asked by Study 1, explains the eligibility criteria and search strategy adopted, the quality appraisal process of included studies as well as the data description and analysis procedures. Results of the systematic literature review are presented next, along the three research questions asked in Study 2. Findings are then discussed and interpreted in relation to the existing body of literature on creativity, technology, and education. Chapter 4 ends with the conclusions drawn from Study 1, its limitations, and implications for the subsequent Study 2.

Chapter 5 presents Study 2 of the a qualitatively-driven sequential multimethod research. It discusses the multiple case study methodology applied to answer the research sub-questions posed in Study 2, explains case selection and presents the sample, details the data collection and analysis methods implemented, clarifies the steps taken to improve research quality, and describes the key ethical considerations. Chapter 5 then describes the findings that emerged from the methodological procedures along the four research questions asked by Study 2. Findings are then discussed and interpreted in relation to the existing body of literature on creativity, technology, learning, and teachers' beliefs and practices. Chapter 5 ends with the conclusions drawn from Study 2 also acknowledging its limitations.

Chapter 6 brings together findings of Study 1 and Study 2 highlighting its key contributions and implications, as well as future directions for research.

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Chapter 2: Literature Review

This chapter reviews the research literature at the intersection of creativity, technology, and education relevant for the qualitative multi-method study of teachers' beliefs and practices of nurturing students' creativity in technology-enhanced learning environments in the present dissertation.

The chapter begins with an overview of creativity (Section 2.1) discussing its research-based definition, theories, models, and assessment relevant to understanding the phenomena in the context of education. The chapter next examines the literature on nurturing creativity in education (Section 2.2) reviewing the state of the art research on creativity development and enhancement to synthetize effective practices. Then, the literature on creativity and technology is discussed (Section 2.3) including the overview of theoretical models describing the potential of digital tools to support creativity and learning as well as the synthesis and appraisal of the evidence provided by technology-enhanced creativity interventions. The existing research base on teachers' beliefs and practices of nurturing creativity is explored subsequently (Section 2.4) with particular focus on beliefs and practices with regard to fostering creativity with digital technology. The chapter ends with a summary (Section 2.5) highlighting the implication from the literature for the study presented in this dissertation.

2.1 CREATIVITY: DEFINITION, MODELS, THEORIES, ASSESSMENT

The term creativity is frequently used in educational contexts without a clear explanation of what is meant by it (Spencer, Lucas, & Claxton, 2012). This often results in a lack of shared understanding of the phenomenon among teachers, students and other stakeholders (Bereczki, 2015; Plucker, Beghetto, & Dow, 2004). In contrast to conventional wisdom, creativity is well-defined defined and there are several research-based models and theories to further enhance the understanding of the concept as well as carefully developed measures to assess its various aspects. The aim of this section is to provide an overview of the research-based definition, theories, models and assessment issues most relevant to understanding creativity in education, which will serve as the

conceptual basis for the present study of teachers' beliefs and practices of nurturing students' creative capacities in technology-enhanced learning environments.

This section begins with the definition of creativity for the classroom (Section 2.1.1) followed by the presentation of the continuum of creativity to highlight the different levels of creative expression that can be achieved through development (Section 2.1.2). Then, a contemporary debate is outlined, namely whether creativity is domain-specific, domain-general or both, which is closely related to the ways in which creative skills can be fostered across the curriculum (Section 2.1.3). A discussion of the most important scientific models is offered next to further explore the complex nature of creativity. (Section 2.1.4). Finally, the assessment of creativity is examined (Section 2.1.5) along with its educational implications. This section ends with a summary restating the main issues identified through the review of the creativity literature relevant for the present study (Section 2.1.6).

2.1.1 Defining creativity

What is meant by creativity in education is often vaguely explained. At first sight, defining creativity in the scientific literature also seems problematic. Parkhust (1999), for example, identified more than a hundred conceptualizations of creativity reviewing educational psychology publications. In a study of definition use in peer-reviewed creativity research, Plucker, Beghetto and Dow (2004) found that of the 90 identified articles, only 34 (38%) provided an explicit definition for creativity, 37 (41%) offered an implicit one, while in 19 (21%) authors did not define creativity at all.

Still, regardless of how many definitions materialize in the literature, researchers currently argue that creativity has been a well-defined concept for decades (Runco and Jaeger, 2012). Runco and Jaeger (2012), for example, highlight the fact that the standard definition of creativity was provided half a century ago. In an article on creativity and culture, Stein (1953) defined creativity as "novel work that is accepted as tenable or useful or satisfying by a group in some point in time" (p. 311). Hence, producing an original, novel or unique outcome is not alone sufficient for creativity. For an outcome to be creative it must also be effective, useful, or appropriate to the task at hand. As Runco (1988) states "originality is vital, but must be balanced with fit and appropriateness" (p. 4).

The conceptualization of creativity as producing outcomes that are both unique and useful have been included in most research and theory based definitions of creativity over time (Kaufman, 2009; Plucker et al., 2004). The standard definition, however, offers only the criteria to judge creativity without saying anything about how, where, or when creativity emerges and who judges it (Runco & Jaeger, 2012). To align the standard definition more closely to advances in the field, Plucker and his colleagues (2004) proposed a comprehensive definition developed through the synthesis of the conceptualizations offered in creativity studies:

> Creativity is the interaction among *aptitude*, *process*, and *environment* by which an individual or group produces *a perceptible product* that is *both novel and useful* as defined within *a social context*. (Plucker et al., 2004, p. 90, emphasis in original)

Widely adopted in the literature, this definition broadens yet contextualizes how creativity is defined, in that it acknowledges that creativity results in outcomes that are both original and appropriate, but also emphasises that it involves an individual or collaborative process and is influenced by various personal and environmental factors.

The synthesis provided by Plucker and his colleagues (2004) can be well adapted to refer to students' creativity in the classroom: students' creativity arises from the interaction among their personal factors and those of the surrounding environment, while the creative outcomes produced by them are judged as novel and useful in the various contexts of the classroom.

2.1.2 A continuum of creativity.

Novelty and usefulness as joint requirements for creativity are largely dependent on the level of expression of creativity in focus. Various levels of creative accomplishments have been identified in the literature. Creativity researchers first differentiated between eminent creativity or Big-C creativity, exhibited by great artists or scientists, and little-c creativity or everyday creativity, which refers to the creative contributions that are useful and important in the context of everyday life (Craft, 2001; Csíkszentmihályi, 1996; Richards, 2007; Stein, 1953).

More recently Kaufman and Beghetto (2007) put forward the Four-C Model of Creativity by adding two more categories to the initial levels: Pro-C and mini-c creativity.

Pro-C creativity or the expert level of creativity describes the works of professionals in a certain domain, differentiating these from forms of everyday creativity. Mini-c creativity is defined as "the novel and personally meaningful interpretation of experiences, actions, and events" (Beghetto & Kaufman, 2007, p. 23).

The Four-C framework thus recognises everybody's potential to be creative as well as proposes a developmental continuum of creativity as illustrated by *Figure 1*.

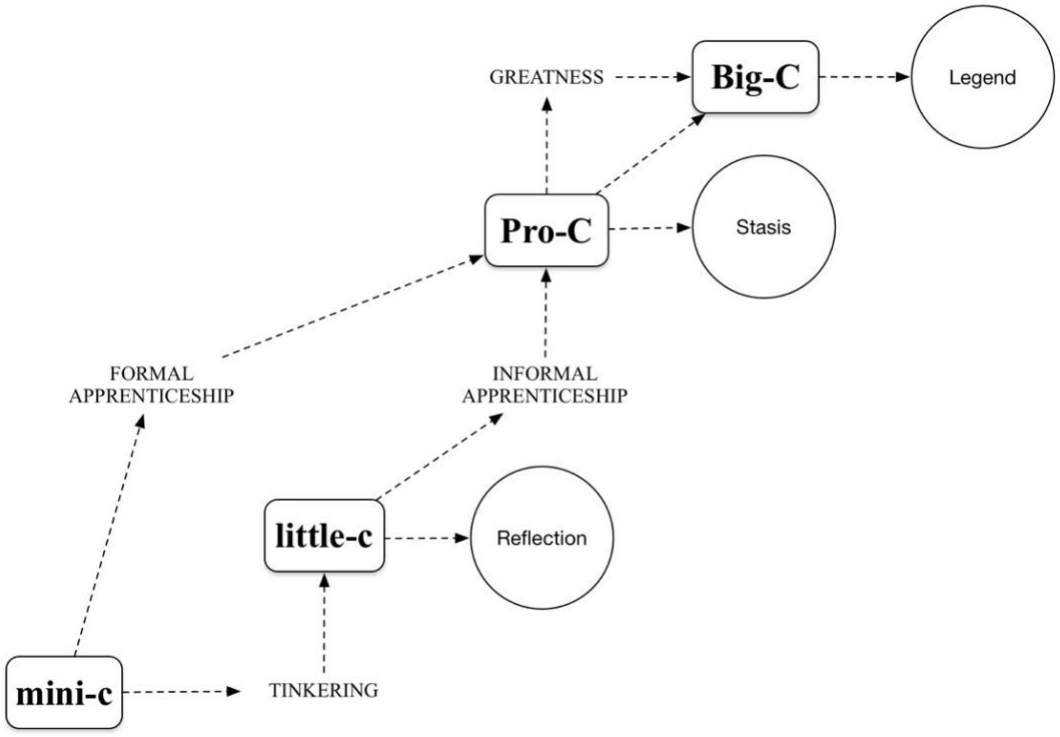


Figure 1. The Complete Four-C Model of Creativity. Based on Kaufman & Beghetto (2009, p. 7).

In the developmental continuum of creativity, mini-c insights represent the origin of all creative endeavours, which with practice, support, and feedback from more experienced others can grow into little-c creativity. By training and mentoring in a certain domain, little-c may progress into Pro-C creativity. Finally, in a few cases, Pro-C will evolve into Big-C creativity leading to creative achievements that make long-lasting impressions to a field (Kaufman & Beghetto, 2009).

This continuum is particularly important for education, since it suggests that individuals do not just happen to be creative, rather it takes encouragement and nurturing to develop mini-c and little-c creativities into later forms of creative achievement.

2.1.3 Domains of creativity

Novelty and usefulness also have strong implications for the domain in which creativity manifests as well as for the knowledge it requires. Creativity is generally seen as relevant to any domain (Runco, 1999), while the domain is understood to provide the knowledge context within which people can be creative (Craft, 2005). Although no one questions the role of domain knowledge in supporting creative achievement, there has been a longstanding debate on whether creativity is domain-general or rather specific to the domain in which it manifests (Baer, 1998; 2010; Plucker, 1998). Researchers have produced solid evidence for both sides (Baer, 1998; 2010, 2011; Kim, 2006, 2011; Plucker, 1998).

The domain-general perspective suggests that creativity is a set of generic skills that can be productively applied in any domain (Baer, 2010). Arguments for domain-generality usually look at personality tests and data (Plucker, 1998, 1999; Kim, 2006, 2011). The premise of these investigations is that if there is high inter-correlation among different creative behaviours and a common set of psychological descriptors for those behaviours, then creativity is domain general (Ivcevic, 2007).

Guilford (1968) argued that creativity is different from intelligence, in that intelligence is the ability to find one correct or conventional answer to a problem, whereas creativity requires the ability to devise divergent ways of solving it. Divergent thinking, the ability to produce multiple diverse ideas, has become the foundation for assessing domain general creativity. The most widely used measure of divergent thinking is the Torrance Test of Creative Thinking (TTCT) (Torrance, 1966, 1974). Research revealed that TTCT has the highest predictive validity among many measures of creativity with its scores predicting children's later creative achievement better than IQ scores (Kim, 2006, 2011; Plucker, 1999). This can be interpreted as evidence that at least certain aspects of creativity are domain-general.

In contrast to the domain-general perspective, the domain-specific view holds that the skills, dispositions, attitudes, propensities, and motivations that together lead to creativity vary from domain to domain (Baer, 2010). Arguments for domain-specificity look at creative outcomes. The premise of these investigations is that if creativity is a general trait then creative outcomes should display a similar level of creativity across different domains.

Many researchers argue that the assessment of the creative aptitude in specific areas as well as the assessment of specific products are more appropriate measures of creativity (Baer, 2010). The prelevant method of measuring domain-specific creativity is the Consensual Assessment Technique (CAT) (Amabile, 1996). Researchers claiming domain specificity often support their views through comparing the CAT scores of products created by the same person across different domains. Evidence for the domain-specificity of creativity have been provided by several studies which revealed low correlations among the creative products created by the same individuals in different domains (e.g. Baer, 1994; Conti, Coon & Amabile, 1996; Palmiero, Nakatani, Raver, Belardinelli, & Van Leeuwen, 2010).

Domain-specific and domain-general views have recently been advanced to a middle-ground position, and it is now widely acknowledged that some aspects of creativity are domain-general while others specific to the domain in which creativity is expressed. For example, Plucker and Beghetto (2004) suggest that creativity has both specific and general components, and that the level of domain-specificity will change with the social context, and with the development of creativity through childhood into adulthood. In their Amusement Park Theory, Baer and Kaufman (2005) posit that while some general factors will influence creative performance in all areas, only several domain-specific factors will-influence creative performance in specific areas. Lubart and Guignard (2004) also argue that creativity requires partly generalized, partly domain-specific, and partly task-specific abilities.

Exploring domain-general and domain-specific evidence has serious implications for understanding, assessing and fostering creativity in the classroom: if at least some elements of creativity are domain-specific, creativity should be conceptualised, nurtured, and measured within the context of each curricular area rather than as an independent generic skill.

2.1.4 Models of creativity

The understanding of creativity can be further enhanced by considering several models offered by the scientific literature. Earlier conceptualizations include Guilford's model of divergent thinking (1950) and Rhodes' Four P framework (1961), while some of the more recent theories comprise Amabile's Componential Model of Creativity

(Amabile, 1983, 1996), Csíkszentmihályi's Systems Approach (1988, 1996), and Sternberg and Lubart's Investment Theory of Creativity (1992).

Divergent thinking

One of the most persistent models associated with creativity is that of divergent thinking proposed by Guilford in 1950. This model provides the framework for the most popular measure of creativity, the TTCT (Torrance 1966, 1974). Divergent thinking is generally understood as a composite idea-generation skill made up of the following of four subskills: (1) fluency, the ability to produce a great number of ideas, (2) flexibility, the ability to generate many different types of ideas, (3) originality, the ability to produce unique and unusual ideas, and (4) elaboration, the ability to develop these ideas. Divergent thinking is an important prerequisite of creativity as well as an indicator of creative potential (Kim, 2006, 2011; Plucker, 1999). Nevertheless, it is important to note that divergent thinking represents merely one aspect of creativity or even that of the creative thought since it emphasises the creative person's ability to generate multiple and varied ideas, but overlooks the ability to evaluate and make creative ideas useful or helpful (Runco & Acar, 2012).

The Four P framework

A wide consensus in the field of creativity research is represented by the conceptualization and observation of creativity within the Four P framework (Kozbelt et al., 2010). Creativity has mainly been investigated and theorized along four strands of foci identified by Rhodes in 1961 and referred to as the Four Ps of creativity. The Four Ps denote the four aspects of creativity: *process*, *product*, *person* and *press/place*.

The *person* aspect of creativity stands for the creative individual or group who generates the creative outcome. Early research on creativity focused on comparing eminent creators in different domains, such as artists, mathematicians, architects, scientists to identify the common traits of highly creative individuals (Kozbelt et al., 2010). Results of these studies revealed that several personal characteristics correlate with creativity, such as intrinsic motivation, wide interests, openness to experience and autonomy (Barron, 1995; Helson, 1972). Others traits have been found to be more pervasive among persons active in either the artistic (e.g. emotionally unstable, sensitive,

imaginative, impulsive) or the scientific domain (e.g. arrogant, self-confident, ambitious, autonomous) (Feist, 1998; 2010). The identified characteristics have been adopted in creative personality scales under the premise that individuals are more creative if they possess them (Kaufman, Plucker, & Baer, 2008). In current research, creative personality characteristics are more viewed as factors that influence creative behaviour rather than explain it (Kozbelt et al., 2010).

The *process* aspect of creativity refers to the mental mechanisms that occur when a person is engaged in a creative activity. Several models of the creative process have been developed in the literature (e.g. Bransford & Stein, 1984; Isaksen, Dorval, & Treffinger, 2000; Wallas, 1926). An integrated framework was offered by Sawyer (2012), who described the eight stages of the creative process as follows: (1) problem finding and problem formulation, (2) acquiring knowledge relevant to the problem, (3) gathering a broad range of potentially related information, (4) taking time off for incubation, (5) generating ideas, (6) combining ideas in unexpected ways, (7) selecting the best ideas, applying relevant criteria, (8) externalizing the idea using materials and representations (pp. 88-90). Study on the creative process investigates the cognitive mechanisms underlying the components of the creative thought, as well as the conscious and unconscious processes involved in creativity (Kozbelt et al., 2010). Major findings of this area include that creativity results from a combination of basic mental capabilities, involves everyday cognitive processes, results from long periods of hard work that involves small insights, and is always specific to a given domain (Sawyer, 2012).

Products are the results of the creative process. Studies in the product category focus on creative outcomes, such as works of art, inventions, publications, musical compositions (Kozbelt et al, 2010). Research in this area aims to quantify how creative products enable the objective evaluation of real-life creativity (Kaufman et al., 2008).

Place/Press represents the setting or climate in which the creative individual or group resides (Rhodes, 1961). Investigations of the creative place focus on the interaction between person and environment, and suggest that despite individual differences in terms of environmental preferences, creativity flourishes where opportunities for exploration and independent work are provided, and where creativity is supported and valued (Kozbelt et al., 2010).

As the conception of creativity developed, two more Ps have been added to the initial framework: *persuasion* (Simonton, 1990) and *potential* (Runco, 2008). Persuasion

studies take the premise that creative people need to change the ways others think to be recognized as creative (Kozbelt et al., 2010), while studies in the potential category investigate the educational side of creativity (Runco, 2008).

Confluence models of creativity

Though the Four P framework is one of the most frequently cited models of creativity in the literature, it has been criticised for failing to capture the intersection of the elements of creativity (Runco, 2008). Rhodes (1961) himself noted that the Four Ps could be examined separately, but attention should be paid to the fact they do not operate in isolation. While early conceptualizations focused mainly on one of the Four Ps and investigated the individual, intrapersonal determinants of creativity, recent theories emphasize the interaction among the several elements that together represent creativity integrating all four, and increasingly the additional two aspects (Kozbelt et al., 2010).

The Componential Model of Creativity (Amabile, 1983, 1996), for example proposes the following ingredients for creativity: (1) domain-relevant skills, which include individuals' knowledge, expertise, technical skills, and intelligence, (2) creativity relevant processes, which Amabile defines as cognitive styles related to taking new perspective, and aspects of personality such as risk-taking, tolerance for ambiguity, ideation and divergent thinking (3) task motivation, and (4) the social environment in which the creative process takes place with aspects including extrinsic motivators, norms or constraints that may operate for or against the individual. According to Amabile, it is the confluence of these factors that determines whether creativity will emerge.

Similarly, Csíkszentmihályi's Systems Model of Creativity (1988, 1996) locates creativity at the intersection of three systems: (1) the domain, which refers to the knowledge of the discipline in certain time, (2) the individual, who makes a novel variation in the contents of the domain, and (3) the field, which is comprised by the members of the discipline who will evaluate and choose the variations worth to be reserved in the domain. Csíkszentmihályi argues that creative achievements cannot be interpreted in vacuum, rather only in a particular historical and social context. Whether creative achievements stand the test of time is largely dependent on the interrelationships between field, domain, and individual. For a visual representation of Csíkszentmihályi's model see *Figure 2*.

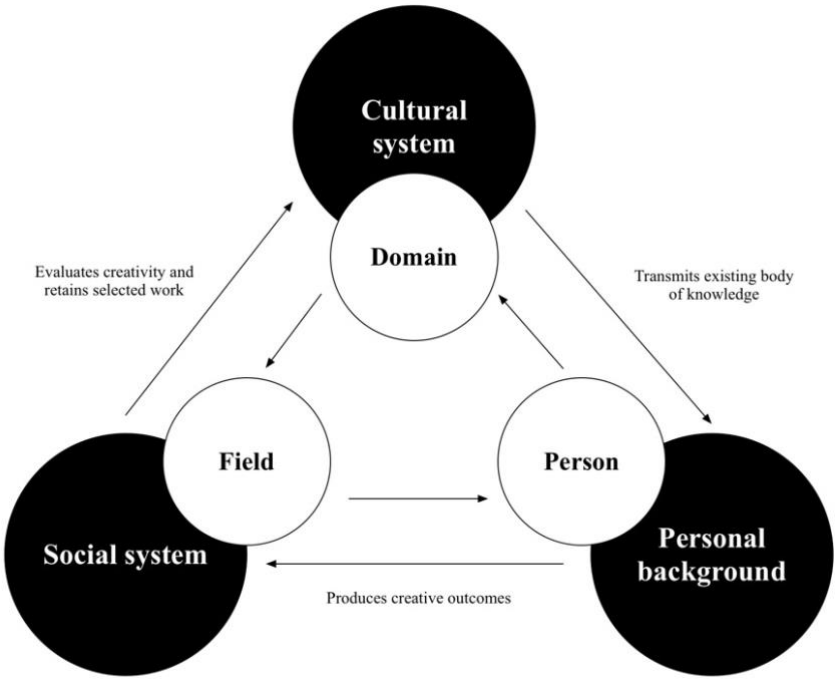


Figure 2. The Systems Model of Creativity. Based on Csíkszentmihályi (1996).

The Investment Theory of Creativity (Sternberg and Lubart, 1992) proposes that creative individuals 'buy low and sell high' in terms of creative ideas and suggests six constructs that together enable creativity: (1) intellectual abilities, including the ability to synthetize and analyse ideas, and persuade others of the their worth, (2) knowledge about the domain or discipline, (3) thinking styles, or preferred ways of using one's skills, (4) personality attributes, such as tolerance for risks and ambiguity, self-efficacy, and perseverance, (5) intrinsic motivation to engage with the task at hand, and (6) an environment which supports the creative individual.

Despite being quite different from each other, these confluence models and theories share several common elements, namely that creativity requires intrinsic motivation, domain knowledge and expertise, divergent and convergent thinking abilities, a particular set of personal characteristics such as openness to experience, tolerance to ambiguity, willingness to take sensible risks as well as a supportive environment. Confluence views thus suggest that students' creative development in the classroom also results from the interaction between their personal factors, including characteristics, knowledge, skills, dispositions, and the environment surrounding them.

2.1.5 The assessment of creativity

One of the essential questions regarding the assessment of creativity is whether creativity can actually be measured. Despite lay reservations and objections, creativity can be assessed. In fact, creativity assessments have been developed, used and evaluated for decades with substantial advancements over recent years (Kaufman et al., 2008; Runco, 2014). The most widely used and promising categories of assessment today include divergent thinking measures, product ratings, and self-assessments.

Divergent thinking measures

The most popular way of measuring creativity is through divergent thinking. As noted earlier, divergent thinking was first posed by Guilford (1950, 1967) and refers to a person's ability to generate multiple and diverse responses to open-ended questions. Divergent thinking is comprised by four subskills: fluency, flexibility, originality and elaboration. Although many measures of divergent thinking have been developed over the years, the longest-running, most carefully studied and widely used is the TTCT (Hunsaker & Callahan, 1995; Kaufman et al., 2008; Runco, 1992; Runco & Acar, 2012).

TTCT (Torrance, 1966, 1974) measures creativity in two domains: verbal and figural. Verbal TTCT is comprised of seven subtests ranging from tasks like the Unusual Uses, in which participants are asked to think of many possible uses for a common object (e.g. a cardboard box) to Just Suppose, in which participants are asked to think of improbable situations and then list possible ramification (e.g. people no longer needing sleep). Verbal TTCT is scored on three categories: fluency (number of relevant responses), flexibility (number of different types of answers), and originality (statistical infrequency of the answers). The figural section of TTCT has three subtests in which participants are required to modify and expand shapes or drawings, and to finish and give a title to incomplete drawings. Figural TTCT is scored for fluency and originality as well as elaboration (the amount of detail in a response), abstractedness of titles (the degree to which the title moves beyond labelling), and resistance to premature closure (the degree to which one keeps an open mind) (Kaufman et al., 2008).

Many reviews suggest that the TTCT is associated with convincing evidence of reliability and validity, although results are sometimes inconsistent (e.g. Hocevar & Bachelor, 1989; Kaufman et al., 2008; Plucker & Renzulli, 1999; Plucker & Runco, 1998;

Runco, 1991). Research on predictive validity reveals that the divergent thinking skills measured in earlier life can predict at least to a certain extent creative accomplishments in adulthood (e.g. Kim, 2006; 2011; Plucker, 1999; Runco, Millar, Acar, & Cramond, 2010). For example, in a reanalysis of Torrance's extensive longitudinal data using advanced statistical methods Plucker (1999) found that TTCT scores were three times better predictors of adult creative achievements than IQ scores. Kim (2006) showed that there were moderate correlations between TTCT and future creative production, which were nevertheless higher than correlations between IQ and later creative achievements. On the other hand, evidence for convergent and discriminant validity are more limited with certain aspects being well-sustained, while others poorly supported (Kaufman et al, 2008).

Product ratings

Many researchers argue that standardized tests cannot measure one's creativity since the tasks they provide are too restrictive and limited to the verbal and figural domains. A common way of assessing creativity is having actual creative products rated by others. There are several approaches to evaluating creative products in the literature from using expert judges who rate creative outcomes to applying straightforward rating product scales (Kaufman et al, 2008).

The most popular way of assessing creative products is through the CAT (Amabile, 1983, 1996). Often referred to as the 'golden standard' of creativity assessment (Carson in Kaufman et al., 2008), CAT is based on actual attempts to assess creative product as they are evaluated in the real-world. When applying CAT, subjects are asked to create an actual product, which is then evaluated by two or more experts in the field. The expert judges independently rate the creativity of the product on a scale of 1–5 without having to explain or defend their ratings in any way. CAT has strong face validity, since it measures actual creative achievement. While the method could raise subjectivity concerns, studies have shown that the ratings of experts and quasiexperts (students with special experience or aptitude in the domain) generally correlate highly (e.g. Amabile, 1996; Kaufman, Baer, & Cole, 2009; Kaufman, Gentile, & Baer, 2005), non-experts, however, were found to generally neither agree with each other nor with experts (Kaufman, Baer, Cole, & Sexton; Kaufman et al., 2008).

Creative outcomes can also be assessed by using product rating scales, which require less expertise than CAT. There are several approaches to rating products, many of which were extensively applied in educational contexts. For example, the Creative Product Semantic Scale (Besmer & O'Quinn, 1993) allows judges to rate creative products along several criteria such as novelty, problem resolution, elaboration and synthesis. The Student Product Assessment Form (Reis & Renzulli, 1991), which has been applied as an evaluation instrument in gifted programs, provides ratings of nine creative product traits including problem focusing, appropriateness of resources, originality, action orientation, audience. Westberg (1996) created an instrument to evaluate student inventions on the criteria of originality, technical goodness, and aesthetic appeal. These rating scales are usually associated with convincing evidence of reliability though their validity needs to be addressed (Kaufman et al., 2008).

Self-assessments

Creativity has also been measured by asking people to report on their own creativity. Some self-assessments are designed to measure creative personality, others, known as creative behaviour checklists ask people to rate their own past or current creative accomplishments (Kaufman et al., 2008).

The most commonly used personality test for creativity is the NEO Personality Inventory (Costa & McCrae, 1992). The test measures personality on the components established by the five-factor personality theory: neuroticism (having emotional stability), extraversion (being outgoing and sociable), conscientiousness (being disciplined and rule-oriented and having integrity), agreeableness (being friendly and good-natured), and openness to experience (having intellectual and experiential curiosity) (Kaufman et al., 2008). Among the five factors, openness to experience has been found to be related to creativity, whether measured by divergent thinking tests (e.g. King, McKee-Walker, & Broyles, 1996; McCrae, 1987), the CAT (e.g. Wolfradt & Pretz, 2001), or self-reports (e.g. Griffin & McDermott, 1998; Soldz & Vaillant, 1999).

Other self-assessment measures include those of creativity styles (i.e. how people use their creativity), creative-self efficacy (i.e. people' s beliefs in their own creative abilities), and creative behaviours or accomplishments. For example, the Runco Ideational Behavior Scale (RIBS) (Runco, Plucker, & Lim, 2000) focuses on ideational

behaviours closely related to creativity, such as the use, appreciation, and skill of generating ideas. Another measure is the Creative Achievement Questionnaire (CAQ) (Carson, Peterson, & Higgins, 2005), which assesses one's past creative achievement across ten domains of creativity from the field of arts and science.

To sum up, the literature provides numerous carefully-designed assessments of creativity which, in addition to research uses, may also have several applications in classroom practice. The open-ended tasks of divergent thinking tests can be modified to fit the curriculum content, existing creative product rating scales can be adapted or new scales can be developed and used as tools for formative assessment, while self-assessments may be valuable for creative personality development, and guidance.

2.1.6 Section conclusions

This section provided an overview of the research-based definition, theories, models, and assessment issues most relevant to understanding creativity in education to serve as the conceptual basis for the present study of nurturing creativity in technology-enhanced learning environments.

The creativity literature reviewed here revealed that contrary to conventional wisdom creativity is a well-defined concept which is widely understood as the production of outcomes that are both novel and useful, involves an individual or a group process, and is influenced by personal and environmental factors. Students' creativity in the present study is thus understood to arise from the interaction between students' personal factors and those of the surrounding environment (an element of which is represented by digital technology), while creative student outcomes produced are judged as novel and useful in the various contexts of learning.

Current literature also showed that creativity is not an inborn or mysterious trait that only selected geniuses possess, but is widely distributed in the population. It has been suggested that creativity has different levels, and there is a developmental progression of creativity from novices to eminent creators. Particularly important for education are mini-c (personal interpretative creativity associated with learning) and little-c (creativity judged as original and useful by others in everyday contexts) creativities, since these are most likely to manifest in the classroom through nurture and encouragement.

Literature synthesized here viewed creativity as relevant to any domain, while the domain was understood to provide the knowledge context for creativity. Research demonstrated that creativity has both domain-specific and general elements suggesting that the best way to nurture creativity is through domain-specific practices across the curriculum. These may also involve the use of digital technology.

Several helpful models were identified to enhance the understanding of creativity in education. Despite being quite different from each other, the models suggested that creativity is a function of intrinsic motivation, domain knowledge and expertise, divergent and convergent thinking abilities, a particular set of personal characteristics such as openness to experience, tolerance for ambiguity, willingness to take sensible risks as well as of a supportive environment. The models reviewed here thus imply that the effective enhancement of students' creative capacities in the classroom, whether supported through technology or not, needs to consider the complexities of creativity.

Finally, the review identified numerous well-developed assessments of creativity. Despite lay reservations and objections, creativity can be assessed through divergent thinking measures, product ratings, and self-assessments. In addition to research uses, several creativity assessments may be modified to support creativity development in the classroom.

With the research-based conceptualization of creativity offered, the next section will describe the place of creativity in education and review the state of the art research regarding its development and enhancement to identify, appraise, and synthesise approaches, methods, techniques, learning environments conducive to creativity in the classroom.

2.2 NURTURING CREATIVITY IN EDUCATION

Once considered an entirely innate and unteachable ability reserved to geniuses, it is now extensively acknowledged that creativity is not a special skill only a few individuals possess, but rather results from specific education and learning. Creativity researchers generally agree that the creative potential is widely distributed among students and it is possible to enhance creativity in education (Beghetto, 2010). This section will first describe the place of creativity in education by discussing the relationships among creativity, learning, and teaching (Section 2.2.1) which is followed

by a review of the state of the art research on creativity development (Section 2.2.2) and enhancement (Section 2.2.3) to identify, appraise, and synthesise approaches, methods, techniques, learning environments conducive to creativity. This section ends with a summary restating the main issues identified through the review of the literature on nurturing creativity relevant for the present study (Section 2.2.4).

Though the focus of the present dissertation is to explore the ways in which technology can be used to stimulate creativity, it is essential to understand the general conditions under which creativity develops, since these may provide the context for the analysis and interpretation of teachers' views and classroom practices.

2.2.1 Creativity, learning, and teaching

The relationship between creativity and academic learning is central to promoting students' creative abilities in the classroom. Creativity can be viewed as independent from learning, sometimes even incompatible with it. This belief held by some teachers is regarded as one of the barriers to nurturing creativity in schools (Beghetto, 2010). In contrast, creativity can be understood as connected to learning, a view recognized and emphasized by a long line researchers who, nevertheless, adopted different approaches to conceptualizing and studying this link (Beghetto, 2016).

First, some researchers conceptualize creativity as a factor influencing learning, while studies in this line of research examine the relationship between students' creativity and academic achievement. Meta-analytic evidence suggests that overall there is a modest yet significantly positive association (r =.22) between creativity and academic learning moderated by the types of measures used for both constructs (Gajda, Karwowsi, & Beghetto, 2016). The relationship between creativity and academic achievement thus appears to depend on the ways creativity and academic learning are conceptualized.

Academic learning can also be understood as a factor influencing creative performance (Beghetto, 2016). Research in this area investigated the relationship between knowledge and creativity, and showed that creativity requires domain knowledge as well as knowing how and when to use domain knowledge to produce creative outcomes (Mumford, Medeiros, & Partlow, 2012; Plucker & Beghetto, 2004).

Finally, creativity and academic learning can be considered as interdependent, a view held by several educational psychologists (Beghetto, 2016). Piaget (1973), for

example, entitled one of his books "To Understand is to Invent", Guilford (1967) asserted that "creativity and learning are much the same phenomenon" (p. 307), scholars in the learning sciences share the view that "learning is always a creative process" (Sawyer, 2012, p. 392). More recently, creativity has been understood as a form of meaning-making and knowledge creation (Craft, 2005; Kaufman & Beghetto, 2007; Runco, 2003). It has been also argued that creativity as a form of meaning making may occur at both subjective and intersubjective levels (Beghetto, 2016; Beghetto & Kaufman, 2007). At the subjective level, students' creativity can manifest in the development of new and personally meaningful ideas and understandings within the context of academic subjects, while at the intersubjective level students who share their unique and academically accurate insights and interpretations can make creative contributions to the learning and understanding of others (Beghetto, 2016; Beghetto & Kaufman, 2007). This view places creativity at the core of education.

Nurturing students' creativity in the classroom can also be considered in relation to three interrelated constructs: teaching creatively, teaching for creativity, and creative learning (e.g. Craft, 2005; Lin, 2011). Teaching creatively is defined as "using imaginative approaches to make learning more interesting and effective" (NACCCE, 1999, p. 89). Teaching for creativity refers to identifying and encouraging young people's creative abilities as well as providing them opportunities to be creative (Jeffrey & Craft, 2004; NACCCE, 1999). Teaching creatively and teaching for creativity are closely interconnected since dynamic, captivating, innovative teaching approaches often inspire students' creativity, while teaching for creativity in turn also requires innovative views and strategies (Craft, 2005; Jeffrey & Craft, 2004; Lin, 2011; NACCCE, 1999). The third element of the model is creative learning, which focuses on learners' experiences rather than on teachers' actions (Craft, 2005). Creative learning has been defined as "learning which leads to new or original thinking which is accepted by appropriate observers as being of value" (Spendlove & Wyse, 2008, p. 8). Researchers suggest that rather than perceiving teaching creatively, teaching for creativity, and creative learning as distinct, focus should remain on the interrelationship between them (Craft, 2005; Jeffrey & Craft, 2004; Lin, 2011).

The present dissertation views creativity and academic learning interrelated and is primarily concerned with teaching for creativity, more precisely with the encouragement and enhancement of students' creative capacities in technology-enhanced learning

environments. Teaching for creativity with technology is nevertheless always understood in relation to teaching creatively and creative learning with technology.

2.2.2 Creativity development

Students' creative growth in the classroom can be informed by research on creativity development. Creativity development has been defined as "the growth in one's ability to generate unique and useful ideas, behaviours, products, and solutions for a given problem, situation, context, or domain" (Beghetto, 2013, p.182). Developmental research focuses on understanding the roots of creativity as well as on identifying the conditions in which creative potential can optimally grow (Kozbelt et al., 2010).

Case study and historiometric research on the lives and family backgrounds of eminent creators has shown that certain contextual conditions, such as being exposed to diverse experiences as a child, experiencing a certain amount of independence, and having parents who were themselves creative in some way correlated with creativity (Kozbelt et al., 2010). Experimental, cross-sectional, and longitudinal studies focused on how creativity emerges in early childhood and develops over time. These studies highlighted an association between creativity and imaginative play, and demonstrated how permissive environments allow for exploration and play, which in turn lead to the development of thinking and behaviours associated with creativity (Russ, 2013). Finally, longitudinal findings pointed to the "fourth-grade slump" in students' divergent thinking (Torrance, 1968) and demonstrated that students can recover from creativity stifling experiences (Torrance & Gupta, 1964; Torrance, 1970). Research in this area also revealed that truly gifted students had adequate support to make cognitive and emotional transitions both from general to creative talent and from capability to motivational states that lead to actual performance (Albert & Runco, 1989).

It can be concluded thus, that creativity is resilient, develops over time, and is influenced by a variety of personal and environmental factors.

2.2.3 Creativity enhancement

Creativity enhancement refers "to bolstering, augmentation, or improvement upon one's creative ability" (Beghetto, 2013, p. 182). Research on creativity enhancement has

produced valuable insights to the ways in which creativity can be encouraged in the classroom, demonstrating that several of its important aspects can be enhanced through well-designed training programs, and various approaches and techniques. In addition, numerous studies have yielded important insights on the environmental conditions that encourage creativity.

Creativity interventions

Several meta-analyses and reviews examined the effectiveness of creativity-fostering intervention programs (Scott et al. 2004a, 2004b; Ma, 2006; Lai et al., 2018). Overall, there is strong meta-analytic evidence that creativity can be enhanced, with studies revealing large and consistent average effect sizes: 0.68 (Scott et al., 2004a), 0.78 (Scott at al., 2004b) and 0.77 (Ma, 2006). In addition, meta-analytic studies have also revealed several characteristics of successful creativity-enhancement programs.

Based on the analysis of 70 studies identified in the literature Scott et al. (2004a) examined the effectiveness of creativity interventions along several criteria such as type of creativity training, course content, the theoretical approach applied, training processes and techniques, delivery methods, as well as in relation to participants' age and background. As Table 1 shows, of the four creativity program categories, the largest effect size was found in studies employing divergent thinking (.75) and problem solving (.84) training. Smaller but still sizeable effects were found for programs focusing on performance, namely the generation of creative products (0.35), and for attitude and behaviour-based training, which targeted the development of reactions to creative ideas, and creative efforts initiated (0.24).

Table 1. Overall effects of creativity training. Based on Scott et al. (2004a, p. 369)

Creativity training	**NE**	**Δ**	**SE**	**CI**	**SD**	**FSn**
Divergent thinking	37	.75	.11	.56-.93	.67	101
Problem solving	28	.84	.13	.62-1.05	.67	90
Performance	16	.35	.11	.16-.54	.43	12
Attitude/behaviour	16	.24	.13	.01-.47	.54	3
Overall	**70**	**.68**	**.09**	**.55-.81**	**.65**	**168**

Note. NE = number of effect size estimates; Δ = average effect size estimate using Cohen's delta; SE = standard error of effect size estimates; CI = 90% confidence interval; SD = standard deviation in effect sizes across studies; FS_N = fail safe N or number of studies needed to decrease effect sizes below .20.

Follow-up analysis revealed further characteristics of successful creativity-fostering interventions. More specifically, programs producing stronger effects employed a cognitive framework in which participants worked with knowledge to generate ideas and emphasised the process of problem finding, conceptual combination, and idea generation. More effective programs also applied model based approaches rather than an ad-hoc assembly of techniques, mapped their content to real world domains, and included realistic practice exercise with social modelling, cooperative learning, and case-based learning techniques.

Another important finding of the meta-analysis was that creativity could be enhanced within various settings, age and ability groups. Creativity interventions, thus, proved similarly effective in both academic and organizational settings (.65 and 1.41 respectively), and similar large effects were found for younger and older participants (.67 for participants younger than 14, and .59 for those older). Additional analysis revealed that certain types of training may be more effective for certain age groups since stronger effects were found with programs focusing on creative attitude and behaviour development in older age groups, while for younger participants, performance-oriented programs proved more successful. Finally, overall high to moderate effect sizes were obtained for non-gifted (.72), low-achieving (.68), and gifted (.38) groups, implying that the value of creativity training holds not only for participants in various settings and of different ages, but also for populations with different intellectual capabilities.

In another meta-analysis of 156 studies involving the expert ratings of creativity-enhancement programs Scott et al. (2004b) used cluster analysis to determine major types of creativity training and meta-analytic data to assess their effectiveness. Scott and his colleagues (2004b) found four major approaches to creativity-enhancement in the literature, namely idea production, imagery, thinking skills, and cognitive training, which all appeared to have some value. For a summary of findings see the following Table 2.

As shown in Table 2, the most frequent category of training was idea production, which involved idea generation, divergent and convergent thinking, and brainstorming exercises with reflection on concrete examples. Idea generation training proved successful with effect sizes ranging from .89 to .66. Imagery training programs, which stressed expressive activities and imaginative, unstructured, and non-realistic exercises, were identified as the most common type of creativity intervention in the literature. Nevertheless, this type of program had the smallest effect size (.43) with most

interventions in the cluster (81%) being also rated as unsuccessful by expert judges. Finally, the highest effect sizes and successful evaluation by experts were found in certain cognitive and thinking skills programs. Critical and creative thinking programs produced an average effect size of 1.80. These programs stressed the development of creative thought processes through a mix of convergent and divergent thinking, and involved substantial realistic practice over a long period of time. Another highly effective program identified was the creative process training (1.08) which emphasised problem finding, idea evolution and solution monitoring, meta-cognition as well as collaborative activities. Cognitive and creative thinking programs thus were shown to offer a promising alternative to traditional idea production interventions, since he effectiveness of latter might be skewed due to the direct training of divergent thinking which was also used as measure of creativity in these interventions.

Table 2. Summary of the effects of creativity training approaches and types. Based on Scott et al. (2004b, pp. 161-163)

Approach	**Type of training**	**N**	**Δ**	**Δ_n**	**xs**	**N_s**	**N_{us}**
Imagery	Imagery training	43	.43	29	1.18	8	35
Idea production	Situated idea production training	40	0.89	7	1.3	12	28
	Structured idea production training	23	0.71	8	1.65	15	8
	Open idea production	15	0.66	4	1.6	9	6
	Computer-based production training	3	0.77	3	1.66	2	1
	Interactive idea production training	2	0.89	2	2	2	0
Thinking skills	Analytical training	8	.49	3	1.12	1	7
	Critical/Creative thinking training	5	1.31	4	1.80	4	1
Cognitive	Conceptual combination training	9	.88	7	1.78	7	2
	Creative process training	5	1.08	3	1.80	4	1
	Analogy training	3	NA	0	1.00	0	3

Note. N=number of studies in the cluster; Δ= average effect size using Cohen's delta; Δn=number of studies providing effect size estimates in cluster; xs=average success; N=number of studies in cluster judged successful; Nus=number of studies in cluster judged unsuccessful.

Ma (2006) examined the effects of various single components and packages of creativity training based on 268 effect sizes in 34 studies. Ma's results revealed relatively large and consistent effect sizes (ranging from .61 to .82) across the five training packages identified, with the exception of the New Direction in Creativity Training Program, which yielded a much higher effect size (1.41) (Ma, 2006). Consistent with Scott et al.'s (2004a)

results, Ma (2006) has also found age moderating the effectiveness of creativity enhancement: the effect sizes were highest in programs targeting secondary school students (.82), followed by those involving college students (.79), and elementary students (.75), while the lowest effect size was produced in kindergarten programs (.49).

Together these meta-analyses present strong evidence that creativity can be fostered with various age and ability groups in both academic settings and beyond. In addition, creativity enhancement appears most effective when interventions target domain-specific creative problem solving or divergent thinking, but also include opportunities to develop creative attitudes and behaviours, provide structured instruction, and employ realistic practice, social modelling, cooperative learning, and case-based learning techniques.

In a recent literature review, Lai and her colleagues (2018) summarized findings of research on creativity enhancement interventions conducted in educational settings in the past 20 years. Synthetizing the empirical evidence of high quality studies employing single group, experimental, and quasi-experimental designs, the authors have identified several recurrent and recent promising avenues for enhancing creativity in primary and secondary schools and in higher education.

- *Holistic long-term curriculum based interventions.* Recent research suggested that long-term well-designed creativity programs infused in more areas of the curriculum (e.g. Learning-to-Think, DISCOVER) have positive effects on primary and secondary school students' creativity and learning (Hu at al., 2013; Maker, Jo, & Muammar, 2008)
- *Problem solving training.* The evidence that creativity can be enhanced through problem-solving has been further strengthened by the recent literature. Domain-general problem-solving training appeared to be effective in enhancing children's creativity in early childhood education (Alfonso-Benlliure, Melendez, & Garcia-Ballesteros, 2013). Domain-specific creative problem-solving infused in the eighth grade physical science curriculum (Kurtzberg & Reale, 1999), college engineering (Chang, Chien, Yu, Chu, & Chen, 2016; Pitso, 2013; Robins & Kegley, 2010), and an undergraduate creativity course targeting multiple domains (Cheung, Roskams, & Fisher 2006) all proved successful in fostering participants' creativity.

- *Observational learning and modelling.* Empirical research suggested that observational learning and exposure to creative models can enhance students' creativity as indicated by studies conducted in the domains of arts and design at primary (Anderson & Yates, 1999) and secondary levels (Greonendijk, Janssen, Rijlaarsdam, van der Bergh, 2013; Yi, Plucker, and Guo, 2015).
- *Metacognition training.* Instruction and practice in creative metacognitive strategies (i.e. practice in becoming aware, monitoring, and regulating one' creative cognition) combined with domain-specific problem-solving was suggested to have positive effects on undergraduate design students' creativity (Hargrove, 2012).
- *Role-play games and improvisation*. Some studies suggested that role playing games and improvisation can encourage creativity in educational settings (Lai et al., 2018). Interventions in this respect targeted the enhancement of domain-general creativity skills through table-top role-playing games infused in an undergraduate creativity courses (Dyson at al., 2016; Karwowski & Soszynski, 2008). Improvisation and role-play integrated in a creative drama class also resulted in significant gains in creativity for the participating undergraduate students (Karakelle, 2009).
- *Diversifying experiences and stereotype reduction.* Exposure to diverse experiences also appeared to support students' creativity. Experiencing unexpected conditions and events (e.g. an environment violating the laws of physics or the making of a sandwich in an unusual order) were found to increase undergraduate students' cognitive flexibility (Ritter et al., 2012). Encountering stereotype inconsistencies (e.g. being exposed to photos of female mechanics) was shown to contribute to more divergent and flexible thinking for some individuals (Gocłowska, Baas, Crisp, & De Dreu, 2014; Gocłowska & Crisp, 2013). Research results also indicated that multicultural experiences (i.e. time spent studying and living abroad) supported undergraduate students' creativity (Madoux & Galinsky, 2009).

Creativity intervention thus highlighted that several aspects of creativity can be enhanced also showing, however, that there is no agreed-on formula or set of instructions for doing so. Yet, interventions described in the literature pointed to several research-

based approaches, techniques and methods which may be used in the classroom to stimulate creativity, many of which might as well integrate the use of technology.

Creativity-conducive classroom environments

Several research studies and conceptual analyses have shown that certain environmental conditions play a crucial role in encouraging or suppressing students' creative development and expression (e.g. Amabile, 1996; Beghetto & Kaufman, 2014; Craft, 2005; Cremin, Burnard, & Craft, 2006; Eisenberger & Shanock, 2003; Renzulli, Gentry, & Reis, 2007). Key aspects of the environment that can affect creativity in the classroom include motivational messages, instructional practices, and learning environments.

Motivational messages

Findings from research on motivation and creativity have provided important insights on the conditions favourable to the development and enhancement of students' creativity. Specifically, creativity was shown to thrive under conditions which support enjoyment, personal interest, involvement, and engagement with challenging tasks. In contrast, creativity can suffer in contexts which promise rewards or incentives for creative work, stress competition and social comparisons, and heighten awareness of monitoring, surveillance, and expectations of evaluative judgments from others (Amabile, 1996; Hennessey, 2010). Nevertheless, there is also some evidence to suggest that competitions can support creativity for some students (Eisenberger & Shanock, 2003).

Instructional practices

Several pedagogical approaches have been identified in the literature to promote students' creativity in the classroom (e.g. Beghetto & Kaufman, 2014; Craft, 2005; Cremin et al., 2006; Renzulli et al., 2007). These generally involve the interplay of the following elements: valuing, encouraging, and fostering students' creative capacities, helping them build knowledge about creativity, teaching them to think creatively as well as providing them opportunities to produce and evaluate creative outcomes across the curriculum. Specifically, creativity researchers have identified numerous personal characteristics such as openness to experience (Feist, 2010), creative self-efficacy (Beghetto, 2006), task motivation (Amabile, 1996), domain knowledge and expertise (Ericsson et al. 1996), risk-taking (Beghetto, 2009), and resilience in the face of criticism

(Sternberg & Lubart, 2010) that one requires to be creative. Creative pedagogical practices encourage such abilities and characteristics in students (Craft, 2005). Modelling creativity for students (Esquivell, 1995) as well as helping them develop knowledge about creativity, and teaching them when to be creative are also considered important elements of creativity-fostering instructional practices (Kaufman & Beghetto, 2013). Finally, in addition to teaching the different tools, techniques, and strategies for stimulating creative thinking such as divergent thinking, brainstorming, problem finding, problem solving (Feldhausen & Treffinger, 1980; Sternberg & Williams, 2006), several researchers have emphasised the encouragement of purposeful outcomes across the curriculum (Craft, 2005; Cropley, 2011; Jeffrey & Craft, 2004; Jeffrey & Woods, 2003; Renzulli, 2017). Appropriate products in the classroom can provide relevance for learners as well as opportunities to evaluate creativity, not just as "an ability to make unexpected suggestions", but in "its own right" (Cropley, 2011, p. 439).

Creative learning environments

Learning environments play at least as great role in creativity as students' personal characteristics (Runco, 2014). Recent research literature on learning environments conducive to creativity in education was summarised by Davies et al. (2013). With respect to the physical environment Davies and his colleagues reported that the flexible use of space, flexibility, and free movement around the space, the availability and incorporation of a wide range of appropriate materials and tools including new technologies, and working in outdoor environments as well as in museums or galleries had an impact on learners' creativity. As for the main features of the pedagogical environment, they noted that novel, exciting learning activities, authentic and realistic tasks, game-like and playful approaches, ensuring idea time, and allowing students to have ownership over learning can stimulate creativity. With respect to the psychosocial environment, empirical evidence suggested that creativity-supportive learning environments can be characterised by relationships based on trust and mutual respect between and among students and teachers as well as incorporate activities in which students can actively collaborate with their peers. Finally, regarding the external features of learning Davies et al. (2013) found that collaboration and involvement with outside agencies either by visiting these or bringing in experts to the classroom can enhance the creative learning environment and help students develop creativity skill.

Research on the conditions conducive to creativity has demonstrated that motivational messages, instructional practices as well as features of the physical, pedagogical, and psychosocial environment all contribute to the expression (or suppression) of students' creativity in educational settings. Digital technologies were shown to be part of the creativity-conducive learning environment, the role they play, however, can only be interpreted within the ecology of the creative classroom.

2.2.4 Section conclusions

This section described the place of creativity in education by exploring the relationships among creativity, teaching, and learning, and then reviewed the state of the art research on creativity development and enhancement to synthetize the approaches, methods, techniques, and conditions conducive to creativity in the classroom.

The literature reviewed here revealed that creativity has a natural place in the classroom due to its interdependent relationship with learning and teaching. It has been indicated that creativity requires knowledge while creative learning may be viewed as a form of personal and interpersonal knowledge construction. Creativity in the classroom has also been suggested to arise from the confluence of teaching for creativity, teaching creatively, and creative learning, which may be explored separately but should be interpreted in relation to each other.

Research on creativity development and enhancement demonstrated that creativity can be enhanced and identified several conditions that influence students' creative growth. Developmental research revealed that creativity is resilient, develops over time, and is affected by a variety of environmental factors. Intervention studies showed that creativity can be enhanced from kindergarten to adulthood both in academic settings and beyond, but there are no agreed-on formulas or set of instructions for doing so. Creativity enhancement seemed most effective when it was systematic, targeted domains-specific cognitive skills, included opportunities to develop creative attitudes and behaviours, involved realistic tasks and practice, as well as collaboration with peers. In addition, recent literature suggested that role-play games and improvisation as well as diversifying experiences for learners may encourage creativity in educational contexts.

Literature on the environmental conditions conducive to creativity indicated that motivational messages, instructional practices, and several features of the learning

environment affected students' creativity. Creativity was generally associated with intrinsic motivators, but competitions were also found to support creativity for some students. Creativity-fostering instructional practices were those which valued and encouraged students' creative characteristics and behaviours, offered students opportunities to think creatively, to produce creative outcomes across the curriculum, and to learn about creativity at the same time. Features of the creativity-fostering learning environments identified included those physical (e.g. flexible space, availability of a variety of tools, materials, and technology, outdoor), pedagogical (e.g. active learning, playful, and authentic tasks, time, student ownership of learning), psychosocial (e.g. trust, mutual respect, collaboration) and external (collaboration with outside agencies)

The overview offered in this section provides a context for the analysis and interpretation of teachers' beliefs and practices of nurturing creativity in technology-enhanced learning environments in this study in several ways. First, teachers' conceptions of the place of creativity in education might influence when, how, where, and why they use technology to promote students' creativity. Second, the identified creativity-enhancement approaches, techniques, and methods may integrate the use technology and can be present in teachers' everyday practices. Third, digital technology constitutes an element of the environment conducive to creativity and their use can only be interpreted within the creative ecology of the classroom.

The next section will review the literature on creativity and technology in education to synthesise the existent research-based approaches, methods, techniques with regard to nurturing students' creative capacities in technology-supported learning environments as well as to identify existing gaps in existing research.

2.3 NURTURING CREATIVITY IN TECHNOLOGY-ENHANCED ENVIRONMENTS

Researchers generally agree that digital technology can make a distinctive contribution to the development of creativity in education by providing new tools, media, and environments for learning to be creative and learning through being creative (Glăveanu, Ness, Wasson, & Lubart, 2019; Loveless 2003; 2007; Lubart, 2005; Nikolopoulu, 2015; Mishra et al., 2013). The view that technology can promote creativity and learning is also shared by teachers across many countries (Cachia & Ferrari, 2010). This section first explores the potential of technology in stimulating students' creativity

(Section 2.3.1), then synthetises empirical research on the effects of digital technology-based creativity interventions (Section 2.3.2) to identify effective approaches, methods, techniques to nurturing creativity in technology-enhanced learning environments as well as to highlight limitations and gaps in the literature on creativity, technology, and education. This section ends with a summary restating the main issues identified through the review and their relevance for the present study (Section 2.3.3).

2.3.1 The potential of digital technology to support creativity and learning

The uses of digital technology to support creativity and learning have been reviewed and theorized in a range of published work in recent years (Glăveanu et al., 2019; Loveless 2003, 2007; Lubart, 2005; Nikolopoulu, 2015; Mishra et al., 2013).

For example, Loveless (2003, 2007) argues that the characteristics of technology can make a distinctive contribution to the development of creativity in education. Her conceptual framework for creativity and technology describes the interaction of three interrelated elements: features of digital technologies, learners' capabilities to express elements of higher order thinking with technology, and creative processes (Loveless, 2003, 2007) as represented by the following *Figure 3*.

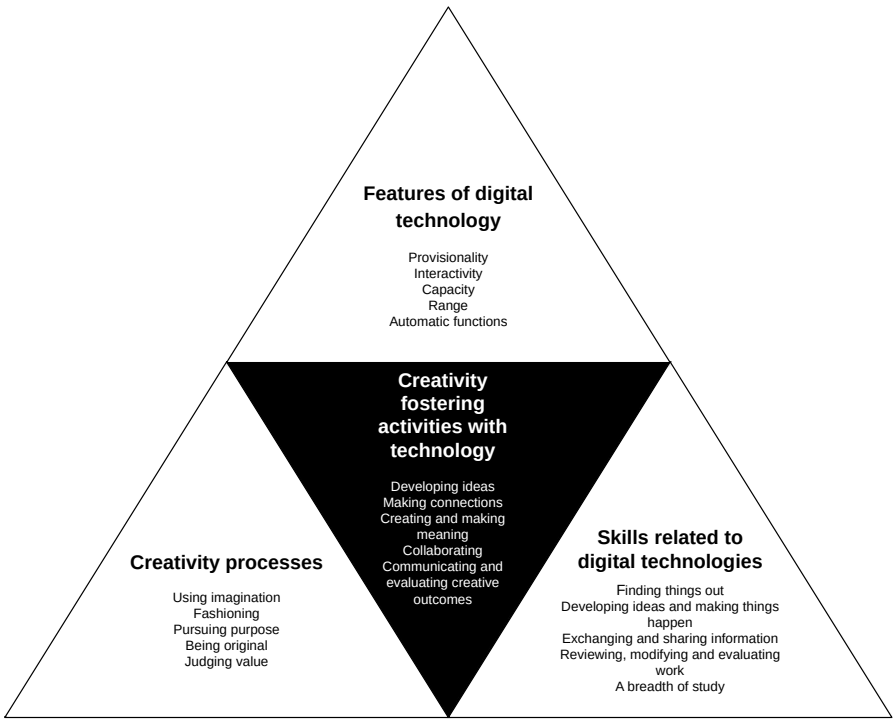


Figure 3. A Conceptual Framework of Creativity and Technology in Education. Based on Loveless (2003, p. 11)

The first element of the Loveless' (2003, 2007) framework is represented by the distinctive features of technology which enable users to do things more effectively or to do things that could not be done before. Such features include *provisionality* (a feature which allows making changes, trying out alternatives, or keeping trace of the development of ideas), *interactivity* (which engages users through immediate and dynamic feedback), *capacity* and *range* (which refer to the ways in which technology can afford rapid access to vast amounts of information, time zones, and geographically different locations), and *automatic functions* (which allow the storing, transforming, and display of information). The next element of the model, namely the capability to express higher order thinking through technology refers to the ability to find things out, develop ideas and make things happen, exchange and share information, review, modify and evaluate work, as well as gain knowledge, skills, and understanding through the means of technology. Finally, the creative processes element is based on the NACCCE conceptualization of creativity (a widely-used framework for creativity in education in the UK) and includes the use of imagination to identify problems and generate ideas, the fashioning process of shaping, refining and managing ideas, the process of producing outcomes from purposeful goals, being original in these outcomes, and judging value through critical and reflective review.

According to Loveless (2003, 2007), creativity-focused activities with new technologies emerge from the interaction of the above described elements and include developing ideas, making connections, creating and making, collaboration, and the communication and evaluation of creative outcomes. Examples, for each type of activities based on Loveless' work (2003, 2007) are provided as follows:

- *Developing ideas*. This area refers to technology-supported activities that enable imaginative conjecture, exploration, and the representation of ideas. Loveless provides several examples which range from using digital simulation and modelling, digital manipulatives, and programmable toys to explore ideas, applying control technology to sense, monitor, measure, and control sequences of events to try out things, engaging in electronic brainstorming, concept mapping, and creating multimedia in exploration and improvisation activities.
- *Making connections.* This area refers to learning to inform, support, challenge, and further develop ideas. Technology may play an important role in making connections with other people, projects, information, and resources through the

Internet. Access to online information may provide resources for the creative work, while access to practitioners such as artists, designers, engineers, and architects can establish networks and communities to ask questions, share expertise and work in progress during the creative process.

- *Creating and making meaning.* During such activities students engage in meaning making through the processes of capture, manipulation, and transformation of media. Technology allows the creation of a multitude of tangible outcomes such as images, poems, drama, 3D constructions, multimedia texts, movies, blogs, webpages.
- *Collaborating.* The speed and range of communication technology enables collaboration with others in immediate and dynamic ways during the creative work, for example, through instant messaging, videoconferencing, chat, email as well as through co-creation in electronic environments. Such activities may offer opportunities to work with others to generate ideas, create, and evaluate ongoing and final work.
- *Communicating and evaluating creative outcomes.* This area refers to the use of technology to present, publish, and communicate the outcome of the creative process. Communication technologies may enable students to celebrate and present their work to a range of audiences. At the same time, considerations of purpose and audience may lead students towards more detailed and careful evaluation of their own creative work, which might in turn result in more creative outcomes. Digital technologies that support these types of activities range from classroom presentations to sharing work using Web 2.0 tools such as blogs, social media sites, school web pages or pages created by students.

Other researchers viewed the role of digital technology in supporting creativity in relation to human-computer interaction (Glăveanu et al., 2019; Lubart, 2005). Lubart in Glăveanu et al. (2019) and Lubart (2005) proposed four social roles that computers (and digital technologies in general) may potentially assume during the creative work: computer as nanny, computer as pen-pal, computer as coach, and computer as colleague. We present these here with a focus on how they each potentially impact creative learning based on Glăveanu et al. (2019):

- *Computer as a nanny.* This role refers to the capacity of technology to facilitate the management of the creative process by providing a supportive environment and access to creative mindset. Technological tools 'acting' as nanny in the creative learning process may include applications that help monitor students' creative work processes as well as offer electronic environments that afford engagement in creativity, or create conditions favourable to its expression.
- *Computer as a pen-pal.* Technology may also facilitate the act of communication and collaboration during the creative process, thus allowing learners to share perspectives, which potentially lead to creative insights. Such technologies range from chat, email, video and audio conferencing, and social media applications to more complex tools, such as co-working platforms that allow distant collaboration on shared objects. Thus, learners may take part in diversified, collaborative projects involving heterogonous teams.
- *Computer as a coach.* Computers as expert systems may be used to enhance student' creativity by providing tutorials and exercises for advancing creativity-relevant cognitive process, strategies, and techniques.
- *Computer as a colleague.* Computers may work in partnership with learners in the creative process by actively contributing to the generation, evaluation, and refinement of ideas. Glăveanu et al. (2019) note that this role will be more emphasized in the future with the advancement of artificial intelligence (AI) in education.

The models presented here are based on theoretical associations rather than empirical evidence, nevertheless they provide useful frameworks to discuss the relationships between creativity, technology, and learning. Also, the reviewed theories suggest that digital technology can be applied to promote and expand students' creativity, but knowledge about both the specific features of digital tools and the characteristics of creativity are necessary to make informed choices of how and when to use them.

2.3.2 Evidence from technology-based creativity interventions

A range of theoretical work has emphasised the potential of digital technologies in supporting creativity in the classroom, nevertheless only few investigated the effects of

technology-enhanced learning interventions on students' creativity (Lai et al., 2018; Ma, 2006; Scott et al. 2004a, 2004b).

The effects of technology-based creativity interventions were examined in earlier meta-analyses already presented in this literature review (Scott et al. 2004a, 2004b; Ma, 2006). Overall, these studies provide meta-analytic evidence that creativity can be stimulated in technology-enhanced environments revealing large average effect sizes for technology-focused interventions: 0.77 (Scott et al., 2004b) and 0.63 (Ma, 2006). These positive results are nevertheless somewhat tempered by the fact they were derived from three early small scale studies which all proved to be successful in promoting students' creativity (Clements, 1991; Howe, 1992; Kobe, 2001). Also, again the real question might not be whether technology-based creativity interventions are effective but rather what technologies and under what circumstances can become powerful creativity-enhancement tools. Clements (1991), for example found that programming with LOGO in project-based mathematics learning increased primary students' divergent thinking both in the figural and the verbal domains, while composing texts with electronic editors had positive effect on their figural creativity. Howe (1992) reported that the use of computer graphic design software in an undergraduate design course significantly increased students' creativity. Kobe (2001) showed that creative problem-solving training can effectively be applied to computer-based environments.

Findings of the recent research on technology-based creativity interventions have not been synthetised in systematic literature reviews or examined through meta-analytic methods. In what follows I will review experimental evidence after 2004 based on studies (1) employing single group, experimental and quasi-experimental designs, (2) providing a basic description of the interventions, and (3) emanating from the past 20 years, identified through hand-searching creativity[1] and educational technology-focused journals[2] as well as through forward-referencing key articles. Findings are synthetized along the seven themes found in literature of technology-enhanced creativity.

[1] Creativity Research Journal, Journal of Creative Behavior, Journal of Psychology, Aesthetics, Creativity and the Arts, Thinking Skills and Creativity, International Journal of Creativity and Problem Solving

[2] Computers and Education, Educational Technology Research and Development, Journal of Computer-Assisted Learning, Journal of Research on Technology and Education

Computer-based creative thinking training

Recent research suggests that computer-based creative thinking training (similarly to its traditional counterpart) can be applied successfully to enhance students' creativity-relevant abilities. For example, in an experimental study involving 24 participants Benedek, Fink, & Neubauer (2006) found that computer-based divergent thinking training positively affected participants' ideational fluency when compared to traditional training. In another study conducted with 51 students and applying single group design, Robbins and Kegley (2010) recorded a significant increase in participants' creative self-efficacy and divergent thinking after taking part in an online creative thinking course based on Thinkertoys (Michalko, 2006).

Computer-based problem-solving

There is some evidence to support the positive impact of computer-based problem-solving on creativity in the recent literature. In a quasi-experimental study conducted with 107 fourth grade students, Chang (2013) investigated the effects of an online problem-solving training integrated in the curricular area of technology on participants' creativity. During the intervention, the experimental groups received instructions online through a webpage which included the instructions to various tasks, animations, discussion boards, paint board, and links to various resources, while controls received traditional instruction on creative problem-solving based on lecturing, designing and making with non-digital tools. At the end of the intervention all participants were asked to construct their own electric model cars. Findings indicated that the intervention group outperformed the control both in terms of divergent thinking and creative production.

Digital game-based creativity enhancement

One recent avenue of research on creativity involves examining the impact of electronic game-based instruction to enhance students' creativity as well as the effects of commercially available video games on young people's creative capacities. Hsiao, Chang, Lin and Hu (2014), for example, evaluated the impact of digital game-based instruction on fifth-graders' creativity and learning in a science course. During the game-based instruction the 27 students in the experimental group engaged in a virtual environment to find the best solutions to game tasks using their imaginative and creative

thinking, and to acquire knowledge in the field of science by collaborating and discussing with peers. This study demonstrated that digital game-based learning may facilitate students' flow experiences and enhance creativity leading at the same time to better learning performance.

While there is a strong theoretical argument that gameplay should increase creativity directly, or mediated through its cognitive, social, emotional, and motivational benefits (Jackson & Games, 2105), empirical evidence on the effects of commercially available video games on players' creativity is still scarce and inconclusive. Moffat, Crombie and Shabalina (2017) compared the effects of three types of videogames, a sandbox game (*Minecraft*), a puzzle game (*Portal 2*), and a first-person shooter (*Serious Sam*) on novice players' divergent thinking skills. 21 undergraduate students in three groups played one of the games for 30-minutes. With findings revealing non-significant short-term effects on participants' fluency and originality, but a significant effect for flexibility in case of *Portal 2* and *Serious Sam*, the authors themselves concluded that further research is required to validate and interpret the results. In contrast, Gallagher and Grimm (2018) conducting a study with an all-female undergraduate sample found that playing *Portal 2* improved participants' creative and spatial abilities over the control group with those in the experimental condition also showing a growing interest and confidence in a variety of STEM-related activities. Also, there is some experimental evidence in the literature to suggest that the high level of arousal associated with playing certain types of video games such as the action game *Light Heroes* (Yeh, 2015) or the party game *Dance Dance Revolution* (Hutton & Sundar, 2010) might positively affect participants' creativity as measured immediately after the game play.

Creative ideation enhancement through electronic brainstorming (EBS)

EBS is a widely researched area in the field of human-computer interaction. Literature suggests that group brainstorming in electronic environments in certain cases may be more effective than traditional brainstorming (DeRosa, Smith, & Hantula, 2007; Michinov, 2005, 2012). This advantage is generally explained by the capability of technology to reduce group inhibiting factors such as production blocking (when group members are prevented from contributing ideas as they occur because only one person may speak at a time), free riding (when group members rely on others to accomplish the task), and evaluation apprehension (when group members withhold ideas and comments

due to fear of negative evaluations) (Diehl & Stroebe, 1991). There is meta-analytic evidence of quantity and quality benefits of idea generation in electronic environments (DeRosa et al., 2007). The success of EBS appears to depend on the size of the group and the way the idea sharing is structured: EBS seems to be more effective than traditional brainstorming when larger groups are involved, and especially when members are allowed time to first produce ideas on their own (DeRosa et al., 2007).

Virtual reality-based creativity enhancement

VR environments offer users access to a theoretically infinite range of experiences, therefore, may have great potential in supporting the creative process (Ward & Sonnebronn, 2009). A number of recent studies have investigated the use of virtual environments to enhance and expand creativity (Guegan et al., 2016; Guegan, 2017; Ritter et al., 2012; Yang et al., 2018). Some studies focused on conditions created in virtual environments that may have a positive effect on users' creativity. It has been found, for example, that using inspiring avatars (i.e. inspiring digital representations of the self) during electronic brainstorming may enhance creativity. Guegan et. al (2016) examined the use of avatars with 54 engineering students who participated in three brainstorming conditions: a face-to-face setting, using neutral avatars, and using inventor avatars perceived as creative by engineering students. Results showed that embodying inventors increased students' originality and fluency. In addition, those who used inventor avatars in the first session continued to be more creative in a subsequent face-to-face task. In another study, Guegan et al. (2017) explored the effects of contextual cues provided in a virtual environment on students' creative performance. 135 psychology students completed a creativity task in three environments: a virtual creativity-conducive environment, a real meeting room, and its virtual replication. Results showed that participants produced more original and elaborate ideas in the creativity-conducive virtual environment than in the other two conditions.

Other studies point at the distinctive role immersive VR environments can play in creativity enhancement. Immersive VR environments are computer system generated three-dimensional (3D) simulation environments in which users can interact with the system in a seemingly real way via electronic devices such as a helmet and a sensor handle or a glove (Riva, 2006). Creating in immersive VR environments or experiencing conditions designed to stimulate creativity also seem to positively affect creativity. Yang

et al. (2018) conducted a study with 60 undergraduates who were asked to design a wearable device that would perform or function as a smart phone. Participants worked in two conditions: in a paper-and-pencil condition and in an immersive VR environment incorporating three dimensional (3D) drawing tools and a human-like 3D model. The immersive VR environment was found to be more beneficial for the quality of the individual creative products as well as helped participants to enter the 'flow' state more easily. The immersive VR environment also led to greater attention levels and more tension for participants. In another study, Ritter et al. (2012) showed that immersive VR environments are effective in diversifying experiences for participants which may lead to greater creativity (Ritter et al., 2012). 61 students were randomly assigned in three conditions: one immersive in which they encountered three unexpected events each violating the laws of physics, one immersive in which the same events happened with expected outcomes, and a non-immersive one in which students watched a video of the same events with unexpected outcomes. Results showed that actively experiencing complex unusual and unexpected events in virtual reality environments increased cognitive flexibility which in turn may allow people to break old patterns and approach problems in new and creative ways.

Stimulating creativity through technology-based communication and collaboration

Communication and collaboration were identified as important elements of the creativity conducive learning environment in the literature (Davies et al., 2013). Research suggests that technology may ease and facilitate communication and collaboration during creative activities. Stolaki & Economides (2018) examined how the use of *Facebook* groups during a creativity-enhancement intervention may contribute to enhancing participants' creativity. 90 undergraduate students enrolled in an information system course took part in the intervention in which small groups of students generated and answered questions to stimulate higher-order thinking posting in a *Facebook* group. Results on the post-test indicated a significant increase in all four areas of student' divergent thinking. It is important to note though that the study adopted a single group design, therefore the positive effect found might not be entirely due to the intervention.

Creating with technology

Though technology has been suggested to offer a variety of new tools for students to create (Loveless, 2003, 2007), only few empirical studies in the reviewed literature investigated the effects of creating with digital tools on students' creativity, the process of their creation, or on the products created. Saorin et al. (2017) examined the effects of digital editing tools and three-dimensional printing used in an educational activity developed to stimulate engineering students' creative competence. 44 engineering students took part in two-hour small group activity in which they created and individualized toy dolls using a wide range of technologies such as a 3D software to create and edit the doll models, a 3D scanner to scan their own heads, and a 3D printer to print the dolls designed by them. Results showed a significant increase in students' figural creativity after the activity. Findings are again somewhat tempered by the convenience sampling and lack of control group in this study.

Limitations of the intervention research reviewed

Findings of the interventions presented here should be interpreted with caution due to several limitations this review was subject to. First, while there was a vast amount of published literature on the topic, most work was either theoretical in nature or failed to provide rigorously available empirical evidence. Second, many of the reviewed studies presented methodological limitations or were not well-suited to provide research-based recommendations for education. For example, few studies incorporated control or comparison groups, thus the increase in students' creativity might not have been due to the interventions, but caused by some other factor. Also, some studies were conducted with voluntary participants and mostly with university students, results are therefore difficult to generalize to primary or secondary student populations. Then, while most studies were conducted over a short period of time, little is known about the long-term effects of technology-enhanced creativity interventions. Finally, the review presented here has its own limitations, in that it is by far not comprehensive or systematic. With limiting the literature search to certain journals though relevant for the topic, important research result may have well been overlooked.

Despite these limitations the following general conclusion can be drawn. Overall, technology-supported creativity interventions highlighted that digital tools may offer new media for teaching creativity, environments to stimulate creativity, as well as new tools

to create, communicate, and collaborate during the creative process, the evidence they provide is, nevertheless, quite limited both methodologically and in scope without revealing much about how digital technologies can be applied to promote creativity across the curriculum.

2.3.3 Section conclusions

This section reviewed the literature on creativity and technology in education to identify theories as well as research-based approaches to nurturing students' creativity in technology-enhanced environments. A range of theoretical work explored the potential of digital technology to support creativity suggesting that digital tools can be applied to promote and expand students' creative capacities across the curriculum. It has been emphasised, nevertheless, that knowledge about both the specific features of such tools and the characteristics of creativity are necessary to make informed choices about their use.

The research surveyed in this section provided some evidence that students' creativity can be developed using digital tools. Findings presented were tempered, nevertheless, by the methodological limitations of studies included, their questionable relevance for primary and secondary education as well as by the shortcomings of the literature identification process itself. Recent research showed that computer-based creative thinking and problem-solving training can be applied successfully to enhance domain-specific and domain-general creative abilities with several benefits over traditional training. Such programs were suggested to have the potential to reach a large number of students in a cost-effective way and contribute to increased performance by promoting multimodal, interactive, self-paced learning as well as provide a safe environment to express creative ideas. While there was a strong theoretical argument that gameplay should increase creativity, research on electronic game-based creativity interventions were scarce and inconclusive with studies conducted mainly in laboratory settings and involving university students as participants. Therefore, little is known about the ways in which digital games could increase primary or secondary school students' creativity in the classroom. Literature also revealed that group brainstorming in electronic environments may increase creative ideational performance. EBS seemed to be more effective than traditional brainstorming when larger groups were involved and especially when members had time to first produce ideas on their own. Though EBS may be relevant

for primary and secondary education, the studies identified focused primarily on university students and adults. Recent research also highlighted the distinctive role VR environments may have in enhancing and expanding creativity by allowing users to experience creativity-stimulating conditions. Specifically, using creative avatars, deigning creativity-stimulating virtual work environments, offering users unusual experiences and opportunities to examine problems from new perspectives were found to enhance creativity. Nevertheless, the classroom relevance of these findings derived from laboratory experiments still needs to be addressed. Finally, the review identified few intervention studies that focused on stimulating students' creativity through technology-based communication and collaboration or on the effects of creating with technology, which revealed little about the conditions and contexts such tools may be used to promote students' creativity in education.

The overview offered in this section is relevant for the present study since the findings of this dissertation on teachers' beliefs and practices of nurturing creativity in technology-enhanced learning environments can be examined against the theoretical models and research evidence summarized here.

The next section will provide a review of the literature related to teachers' beliefs about creativity and their relation to practice to synthetise relevant theories and research in the field as well as to identify gaps and limitations the current study aims to address.

2.4 TEACHERS' BELIEFS AND PRACTICES OF NURTURING CREATIVITY

As Bandura (1997) argued, beliefs rather than truths guide our goals, emotions, decisions, actions, and reactions. Teachers' beliefs are important in educational research and often considered as the key to understanding teacher effectiveness (Bandura, 1997; Nespor, 1987; Pajares, 1992). Creativity researchers also agree that the beliefs teachers hold about creativity shape the ways in which they engage in the promotion of students' creative capacities in the classroom (Andiliou & Murphy, 2010; Beghetto, 2010; Skiba et al., 2017). This section will discuss the literature on teachers' beliefs of nurturing creativity and their relation to practice. First, the definitions and characteristics of teachers' beliefs (Section 2.4.1) and the relationship between beliefs and practice (Section 2.4.1) will be discussed, which is followed by the definition and conceptualization of

beliefs for the present study. The next section will review of the literature on teachers' beliefs and practices of nurturing creativity (Section 2.4.2). The section concludes with a reflection on the literature and their implications for the present study (Section 2.4.4).

2.4.1 The nature of teachers' beliefs: Definitions and characteristics

Teachers' beliefs have been conceptualized and explained in various ways by researchers and theorists, leading to considerable divergence in definitions, terminology, measurement, and interpretations (Fives & Buehl, 2012; Kagan, 1992; Pajares, 1992; Richardson, 1996; Skott, 2015; Thompson, 1992). This multitude of approaches reflects the complex, multifaceted, and varied nature of teachers' beliefs, also suggesting that though important for education, they are difficult to study (Fives & Buehl, 2012; Skott, 2015).

Beliefs are often considered messy which is evident in the lack the of clear terminology and a unified definition of the concept (Pajares, 1992). Indeed, the term belief has been used interchangeably in the literature with a variety of other terms including attitudes, values, judgments, opinions, ideology, perceptions, conceptions, conceptual systems, dispositions, implicit theories, explicit theories, internal mental processes, action strategies, rules of practice, and perspectives (Pajares, 1992). In addition, researchers use different definitions for the concept, each emphasising particular characteristics and functions of teachers' beliefs (Fives & Buehl, 2012). Pajares (1992), for example, defined the concept as "An individual's judgement of the truth or falsity of a proposition" (p. 132). Richards (1996) argued that the term describes "a proposition that is accepted as true by the individual holding the belief" also differentiating it from knowledge which in contrast "implies an epistemological warrant" (p. 104). According to Thompson (1992), beliefs are dynamic systems "of permeable mental structures susceptible of change in the light of experience" (p. 140), while in Kagan's view (1992), beliefs are "teachers' implicit assumptions about students, learning, classroom, and the subject matter to be taught […] relatively stable and resistant to change" (pp. 65-66).

Despite of the terminological divergence and lack of an agreed-upon definition, researchers have found sufficient consensus about the core of the concept for continued research to make sense (Fives & Buehl, 2012; Pajares, 1992; Richardson, 1996; Skott, 2015). The main aspects of teachers' beliefs have been synthetized by Fives and Buehl

(2012) in an extensive review of the literature based on 300 empirical studies and seminal reviews. Teachers' beliefs were thus found to have the following characteristics:

- Beliefs are mainly implicit (e.g. Kagan, 1992), but also explicit to the teachers (e.g. Rimm-Kaufman, Storm, Sawyer, Pianta, & LaParo, 2006). This holds the implication that implicit beliefs (i.e. beliefs teachers are unaware of) cannot be studied or measured directly, but rather inferred based on interview responses and observations, while the study of explicit beliefs (i.e. conscious beliefs) may be threatened by social desirability bias, teachers' inability to articulate their own beliefs, or lack of awareness about them.
- Belief fall along a continuum of stability with older beliefs tending to be more stable, while newly formed ones are most likely to be more dynamic (e.g. Kagan, 1992; Thompson, 1992).
- Beliefs have both content-specific and content-general aspects, and certain beliefs are activated by the demands of specific contexts (e.g. Fives & Buehl, 2008).
- Beliefs are interwoven with knowledge although may be difficult to differentiate them empirically (e.g. Fives & Buehl, 2008).
- Beliefs exist in a complex, multidimensional systems with certain beliefs being more central than others (e.g. Bryan, 2003; Manosur, 2008).
- Beliefs are related to teachers' practices and student outcomes even if the enactment of beliefs may be hindered by individual and contextual factors (Fives & Buehl, 2012).

Conceptualizing teachers' beliefs along these aspects may enhance the understanding of the notion as well as guide research.

Another way of addressing teachers' beliefs is through their content. Researchers have focused on several topics in the investigation of teachers' beliefs, ranging from teachers' self-efficacy beliefs (Bandura, 1997) to beliefs about instructional practices (e.g. Akcay, 2007) or students (e.g. Skott, 2009). Based on the review of existing research evidence, Fives and Buehl (2012) suggest that teachers' beliefs include those about the self, context and environment, content or knowledge, specific teaching practices, and students.

In addition to approaching beliefs through their characteristics and content, another important issue to consider is the function or purpose they serve. Literature suggests that beliefs serve as filters, frames, and guides for teachers' actions (Fives & Buehl, 2012). The filter role is reflected in the way in which beliefs influence teachers' perception and the interpretation of information and experience. Research suggests that when information and experience are congruent with existing beliefs, new beliefs are easier to adopt (e.g. Lee, Baik, & Charlesworth, 2006). Beliefs are also suggested to filter out information that is not seen as relevant (Yerrick, Parke, & Nugent, 1997). As frames, beliefs act as frameworks for decision making. For example, teachers' beliefs may act as a frame for what teachers perceive to be the task at hand when interpreting (filtering) pedagogical reforms (Enyedi, Goldberg, & Welsh, 2006). Finally, certain beliefs function as guides for action influencing which steps teachers will take in a particular situation. Examples of such beliefs may include teachers' motivational, self-efficacy, outcome expectancy, or value beliefs (Fives & Buehl, 2012). All three of these functions highlight the connection of beliefs to teacher practice.

2.4.2 The relationship between teachers' beliefs and practices

The importance of research on teachers' beliefs rests in their possible relationship with practice and ultimately student outcomes (Calderhead, 1996; Fives & Buehl, 2012; Pajares, 1992; Richardson, 1996). Several studies have explored the connections between teachers' beliefs and enacted practices. Research has been conducted focusing on different content areas such as English (Holt & Reynolds, 1994), mathematics (e.g. DeCorte, Vershaffel, & Depaepe, 2008; Skott, 2009), science (Enyedi et al., 2006), various approaches to teaching and learning, such as constructivist views (e.g. Lim & Chai, 2008), general pedagogical practices, for example technology integration (e.g. Chen, 2008), and questioning (Sahin, Bullock, & Stables, 2016) or content-specific pedagogical practices like teachers' views about the use of inquiry-based learning in mathematics and science (Akcay, 2007).

Despite extensive research, the body of evidence relating teachers' beliefs to classroom practices is conflicting. A number of studies suggest that teachers' beliefs are congruent with their practices (e.g. Lefevebre, Deaudelin, and Loiselle, 2006; Mansour, 2008). For example, Mansour (2008) found that personal religious beliefs and experiences played a significant role in shaping science teachers' beliefs and practices.

Similarly, in a study on teaching conceptions and practices with digital technology Lefevebre, Deaudelin and Loiselle (2006) found that teachers' beliefs in the examined areas were strongly associated with teachers' conceptions of the teaching and learning process. In contrast, other studies revealed inconsistency between beliefs and practices (e.g. Lee, Baik, & Charlesworth, 2006). In a study of Korean kindergarten teachers', Lee et al. (2006) found there was no difference between those teachers' practices who held developmentally appropriate and those who held inappropriate beliefs. Finally, a third group of studies revealed different levels of congruence between teacher' beliefs and practices (e.g. Molfese, & Molfese, 2008; Ng & Rao, 2008). In this respect, Ng & Rao (2008) found that early childhood education teachers expressing constructivist beliefs enacted both constructivist and instructivist classroom practices.

Reasons for the incongruence and varying degrees of congruence between teachers' beliefs and practices were identified by Fives and Buehl (2012). Based on the empirical research reviewed, the authors conclude that inconsistencies between beliefs and practices may be explained by the role that a particular belief has in teachers' beliefs system. Thus, a teacher might hold and express a certain belief, nevertheless other related beliefs might impinge on the actual practice enacted. Second, Fives and Buehl (2012) suggest that the lack of relation between beliefs and practice might also be due to methodological issues: small scale quantitative investigations looking at correlations between quantitative self-reported beliefs and observations or self-reported practice measures may obfuscate the complexity of the relationship between beliefs and practices. In contrast, in qualitative and mixed-method studies collecting data through interviews, questionnaires, observations, document analysis from a small number of participants and carrying out detailed analysis, incongruences might be due to the richness of data and in depth analysis. Other reasons for incongruence cited by the authors include the level of specificity at which beliefs and practices are measured, and the extent to which beliefs are newly formed. Finally, Fives and Buehl (2012) note that teachers may express beliefs they do not hold or may not feel free to enact the beliefs they hold.

Research suggests that the implementation of teachers' beliefs is dependent on internal and external supports and challenges (Fives & Buehl, 2012; Kagan 1992; Pajares,1992). Several internal factors that influence the enactment of teachers' beliefs have been identified in the literature such as teachers' knowledge (e.g. Akcay, 2007) or self-efficacy beliefs (Enyedi et al., 2006). Contextual factors may include culture (e.g. Ng

& Rao, 2008), sociocultural shifts (e.g. Seaman, Szydlik, Szydlik, & Beam, 2005), educational policies (e.g. Kwon, 2004), school culture (e.g. Barkatsas & Malone, 2005) as well as factors of the immediate environment such as classroom control, students' and parents' reactions (Enyedi et al., 2006). These factors together may support or hinder the enactment of teachers' beliefs in education.

Overall, research on the relationship between teachers' beliefs and practices yields contradictory results. Putting findings under scrutiny, nevertheless, suggests that rather than discounting the power of beliefs, emphasis should be placed on the exploration of the mechanism that determine potential relationships between beliefs and practice as well as on the identification of the possible internal and external factors that may support or hinder the enactment of teachers' beliefs.

2.4.3 The conceptualization of teachers' beliefs for the present study

The present study adopts Pajares's (1992) definition of belief as "an individual's judgment of the truth or falsity of a proposition" (p. 316) and recognizes that teachers may possess beliefs regarding a variety of issues related to teaching (e.g. creativity, learning, knowledge, curriculum, instruction, assessment, educational technology, students) at various levels of specificity. The study acknowledges that some views are implicit, while others are explicit to the teachers, and that the attempts made to express implicit beliefs may bring these beliefs to the explicit realm. Teachers' beliefs are also considered to exist within a complex, interconnected, and multidimensional system in which incompatible and inconsistent beliefs may coexist (Fives & Buehl, 2012). The study also holds that there is a degree of plasticity in teachers' beliefs, especially with regard to beliefs about nurturing creativity which might be newly formed in teachers and thus can change with time and experience more easily. Knowledge and beliefs are viewed as separate in this study, with knowledge considered as externally verifiable (Richards, 1996), whereas beliefs as subjective claims that the individual accepts as true (Pajares, 1992). Finally, beliefs are seen as serving different functions, specifically to filter, frame, and guide teachers' experience, decisions, and actions (Fives & Buehl, 2012).

2.4.4 Teachers' creativity beliefs and practices

The beliefs teachers hold about creativity shape the ways in which they promote students' creative capacities in the classroom (Andiliou & Murphy, 2010; Beghetto, 2010; Skiba et al., 2017). The study of teachers' creativity-related beliefs and practices was for long a neglected field (Fryer & Collings, 1999) with only a handful of studies investigating the topic prior to 2010 (Kleiman, 2008). In a review of existing literature Andiliou and Murphy (2010) found 17 empirical studies exploring teachers' creativity-related pedagogical beliefs which produced valuable evidence on how teachers' view the nature of creativity, creative students, and the creativity-fostering environment. A conceptual framework of how researchers approached teachers' beliefs about creativity in the literature before 2010 proposed by Andiliou and Murphy is presented in the following *Figure 4*.

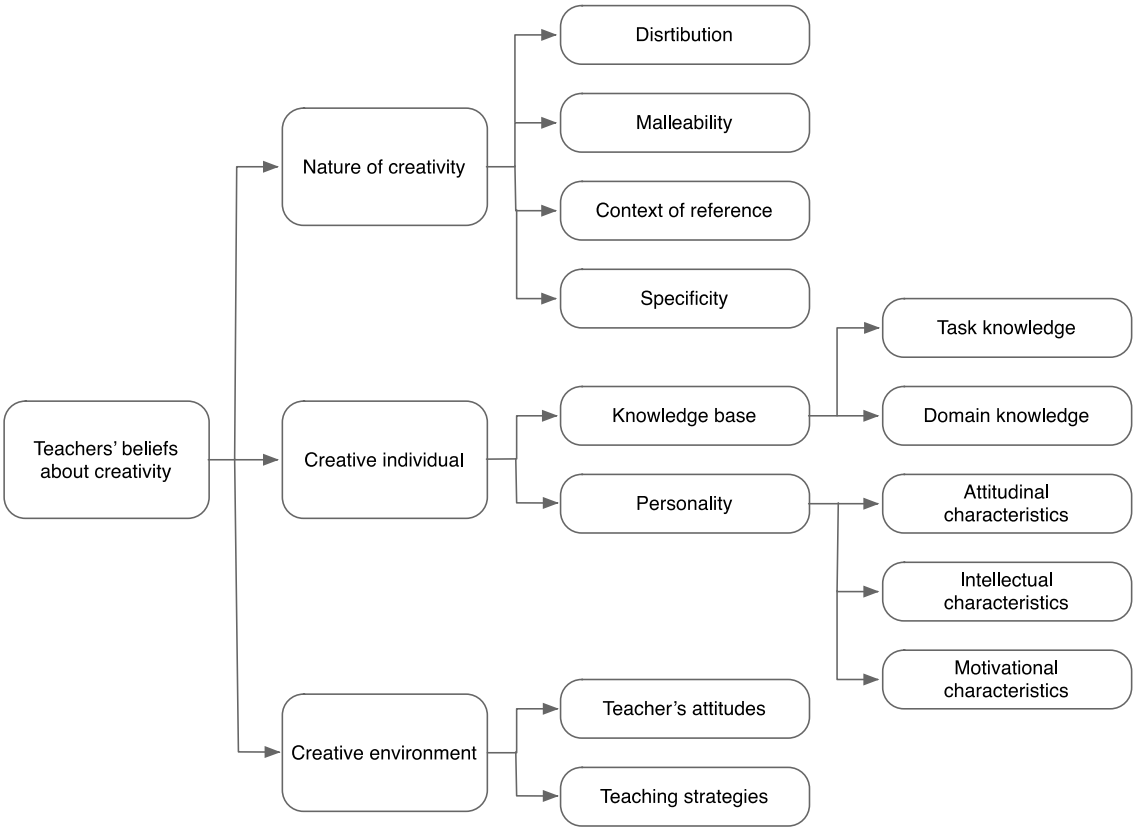


Figure 4. Teachers' beliefs about creativity: the derived conceptual framework. Based on Andiliou and Murphy (2010, p. 2014)

With respect to the nature of creativity, earlier research highlighted several misalignments between teachers' beliefs and the scientific theories of creativity. For example, it was found that teachers mainly associated creativity with originality, uniqueness, imagination, but rarely appropriateness (Aljughaiman & Mowrer-Reynolds,

2005; Cheung, Tse, & Tsang, 2003; Diakidoy & Kanari, 1999; Fryer & Collings, 1991). Also, creativity was often linked to particular domains, more specifically to the arts and humanities (Aljughaiman & Mowrer-Reynolds, 2005; Kampylis, Berki, & Saariluoma, 2009), and especially to the creation of literary and artistic products (Aljughaiman & Mowrer-Reynolds, 2005; Cheung et al, 2003). Studies investigating teachers' beliefs about the profiles of creative students indicated that educators tended to label intelligent students, and those with socially desirable characteristics creative, while students displaying creative characteristics identified seemed to be less preferred in the classroom (Chan & Chan, 1999; Runco & Johnson, 2002; Westby & Dawson, 1995). As for teachers' beliefs about creativity-fostering environments, earlier research suggested that teachers acknowledged the fact that creativity could be fostered (Aljughaiman & Reynolds, 2005; Cheung et al., 2003; Fleith, 2000; Fryer & Collings, 1991; Kampylis et al., 2009; Park et al., 2006) and believed in their own capacities to foster it (Diakidoy & Phtiaka, 2002; Fleith, 2000), but indicated that there were environmental constrains that prevent them from doing so (Aljughaiman & Reynolds, 2005; Cheung et al., 2003; Diakidoy & Phtiaka, 2002; Fleith, 2000; Fryer & Collings, 1991; Park et al., 2006).

While these studies produced valuable insights on what teachers' might think about various aspects of creativity at a given moment in time by gathering cross-sectional survey data (Andiliou & Muprhy, 2010), only few explored in depth the ways in which how teachers conceptualized creativity and translated them to classroom practices. Research using either qualitative or mixed methodology to investigate teachers' beliefs was relatively scarce (Andiliou & Murphy, 2010). Also, research on teachers' beliefs focused predominantly on teachers' misconceptions in relation to the scientific theories of creativity rather than on generating new themes for research with a few exceptions (Craft et al., 2007; Chapell, 2007). In addition, none of the studies included in Andiliou and Murphy's review (2010) focused on teachers' beliefs about and practices of nurturing creativity in technology-integrated environments.

Creativity has become an important issue in mainstream education, and since teachers are key persons in fostering it, there has been an upsurge of interest in examining teachers' beliefs and pedagogical practices regarding the promotion of students' creative capacities in education. New studies have been conducted across cultural settings (e.g. Zhou et al., 2013), in the context of primary (e.g. Cheng, 2010) and secondary (e.g. Daskolia, Dimos, & Kampylis, 2011) education, within different subject areas, such as

maths (e.g. Leikin et. al, 2013), science (e.g. Newton & Newton, 2010), EFL (e.g. Al-Nouh, Abdul-Kareem, & Taqi, 2014), using both quantitative (Leikin et al., 2013), qualitative (Lev Zamir, Leikin, 2011) and mixed methodologies (e.g. McLellan & Nicholl, 2013). In addition, certain studies incorporated teachers' beliefs about nurturing creativity with technology, too. For example, Cachia and Ferrari (2010) in a survey study of European teachers' beliefs found that a vast majority of participants considered technology to enhance creativity. Then, a phenomenological study of US teachers found that participants identified technology both as enabler and barrier to creativity in the classroom (Scott, 2015). In a mixed method study on creativity-fostering beliefs and teacher behaviours, Hondzel (2015) highlighted that several Canadian primary teachers used technology in the lessons observed, but did not discuss explicitly how technological tools might foster students' creativity in their classes during the interviews. These studies, though offering valuable insights, revealed little about what teachers think about and how they use technology to promote creativity in the classroom.

Overall, the review of the literature on teachers' beliefs about creativity revealed that an update to the earlier systematic review is necessary to synthetize new evidence on the topic, and with special focus on the beliefs and practices of nurturing creativity in technology-integrated environments. Such a review could configure the investigation of teachers' beliefs about nurturing creativity in technology-integrated learning environments, which were found to be dearth based on the preliminary review.

2.4.5 Section conclusions

This section discussed the literature on teachers' beliefs of nurturing creativity and their relation to practice to synthetize relevant theories and empirical findings as well as to identify the gaps and limitations that the current multimethod study aims to address.

After reviewing the most important definitions, core characteristics, contents, and functions of teachers' beliefs as well as examining the literature on their relationship with practice, a conceptualization of teachers' beliefs for the present study has been offered. Based on Pajares (1992) and Fives and Buehl (2012) teachers beliefs in this study have been conceptualized as (1) to refer to teachers' representation of reality or what they hold to be true regardless whether there is evidence to support that representation, (2) to be both implicit and explicit, (3) to fall along continuum of stability and specificity, (4) to

have a degree of plasticity, (5) to exist in a complex system, and (6) to be related to teachers' practices with several personal and contextual factors supporting or hindering enactment.

Next, a review of the earlier research on teachers' beliefs and practices of nurturing creativity has been offered, which highlighted that though studies produced valuable insights, only few explored teachers' conceptualizations of creativity and their translation to classroom practices in-depth. Furthermore, none of the studies included in the earlier review (Andiliou & Murphy, 2010) focused specifically on teachers' beliefs about and practices with nurturing creativity in technology-integrated environments. A preliminary overview of new evidence indicated that there was an increase in interest towards teachers' beliefs about creativity, including those regarding its nurture in technology-integrated environments. Therefore, it has been concluded that (1) there is a need to synthetize recent findings on teachers' beliefs about creativity and its relation to practice, with special focus on the role of technology to nurturing creativity, as well as (2) to explore in-depth teachers' beliefs about and practice of nurturing creativity in technology-integrated environments.

2.5 SUMMARY AND IMPLICATIONS

Chapter 2 presented the literature this research on nurturing creativity in technology-enhanced learning environments was informed by. First, an overview of the research-based definition, theories, models, and assessment issues most relevant to understanding creativity in education was provided which serves as the conceptual basis for the present study. Second, the literature on nurturing creativity in education was examined to identify theoretical models and synthetize effective practices. The literature on creativity and technology was discussed next including an overview of the potential of digital tools to support creativity and learning as well as a synthesis and appraisal of the evidence provided by technology-enhanced creativity interventions. Finally, the existing research base on teachers' beliefs and practices of nurturing creativity was explored highlighting the limitations and gaps this study wishes to address.

Significant issues identified from the literature that contributed to the design of the study included: (a) the importance of using a system approach to comprehensively understand how teachers promote students' creative development and enhancement in the

classroom; (b) a need for more empirical studies on how students' creativity can be nurtured in K-12 settings; (c) a dearth of research about nurturing creativity in technology-integrated learning environments with relevance for the classroom; (d) a lack of synthesis of teachers recent beliefs and practices of nurturing creativity in K12 settings; and (e) a dearth of research on teachers' views and practices of nurturing creativity in technology-enabled learning environments

Therefore, this study was designed to elucidate on teachers' beliefs about and experiences with nurturing student creativity in technology-integrated learning environments to generate themes and questions for future research on creativity, learning and technology grounded in the realities of the classroom.

Chapter 3: Research Paradigm and Design

This chapter describes the research paradigm and design adopted by this study to achieve the aim of exploring teachers' beliefs about and practices of nurturing creativity in technology-integrated learning environments as stated in Section 1.2 of Chapter 1. First, the research paradigm adopted for this study will be discussed (Section 3.1), which is followed by the presentation and the discussion of the appropriateness of the qualitatively-driven multimethod design applied (Section 3.2). Research methodologies for the individual studies comprising this qualitatively-driven multimethod investigation will be discussed in subsequent Chapter 4 for Study 1 and Chapter 5 for Study 2.

3.1 RESEARCH PARADIGM

Research in the social sciences is grounded in philosophical assumptions about the world. Termed in the literature as 'paradigm' (Guba & Lincoln, 1994), but also as 'worldview' (Creswell, 2014; Guba, 1990), 'epistemologies and ontologies' (Crotty, 1998) or 'broadly conceived research methodologies' (Neuman, 2009), the beliefs and values researchers hold have implications for every decision made in the research process and therefore need to be identified and described in the study (Creswell, 2014; Mertens, 2010). There are four widely discussed research paradigms in the literature: postpositivism, constructivism, transformativism, and pragmatism (Creswell, 2010; Guba & Lincoln, 1994, 2005; Lather, 1992; Mertens, 2010). Of these, the pragmatic paradigm guided the research design of the present study.

Any paradigm may be described along four fundamental questions proposed by Guba and Lincoln (2005): (1) the ontological question asks, 'What is the nature of reality?', (2) the epistemological question asks, 'What is the nature of knowledge and the relationship between the knower and the would-be known?', and (3) the axiological question asks, 'What is the role of values in the inquiry ?', (4) the methodological question asks, 'How can the knower obtain the desired knowledge and understandings?'. The next sections will provide a short overview of the major research paradigms along their paradigm defining aspects: ontology, epistemology, axiology and methodology (Section

3.1.1), followed by the discussion of how the pragmatic paradigm guided the present study (Section 3.1.2).

3.1.1 Major research paradigms

In the acquisition of scientific knowledge two paradigms have usually dominated the field of social science: positivism and constructivism (Creswell, 2010; Guba & Lincoln, 1994, 2005; Lather, 1992; Mertens, 2010). As a dominant paradigm in early research, positivism lies on the assumption that the social world can be studied the same way as the natural world. The goal of positivist research is to discover general laws that describe constant relationships between variables through experimentation and the measurement of what could be observed (Creswell, 2014; Mertens, 2010). The scientific knowledge gained this way is believed to be objective and the only valid, certain, and accurate form of knowledge (Crotty, 1998). A milder form of positivism is represented by postpositivism, which questions the ability of researcher to establish generalizable laws applicable to human actions and behaviour (Creswell, 2014; Mertens, 2010). Postpositivism acknowledges that facts are theory laden, yet continues to emphasise objectivity and generalizability while suggesting that claims should be established based on probability rather than certainty (Mertens, 2010). Research methods in the positivist and postpositivist paradigm are borrowed from natural sciences and involve mainly quantitative methodology.

In contrast, the constructivist view holds that rather than being singular, stable, and generalizable, knowledge is socially constructed and that the researcher's goal is to understand the complex world of lived experience from the perspective of those who live it (Mertens, 2010). With multiple social constructions of meaning, reality is thus limited to context, space, time, and individuals or groups in certain situations (Guba & Lincoln, 1994). Inquiry in the constructivist paradigm is value-bound and value-laden, which is explicitly acknowledged in the study (Guba & Lincoln, 1994). Studies carried out in the constructivist paradigm utilize mainly qualitative methods applied in accordance with the assumption that research can be conducted only through interaction between and among investigator and respondents (Mertens 2010).

For a long time, the postpositivist and constructivist approaches to understanding the social world had been deemed irreconcilable with one another due to their contrasting

claims about truth and how knowledge is acquired of those truths. However, as social science has matured and started dealing with ever more complex issues, alternative views to knowing and doing research have emerged. These include the transformative perspective, usually associated with participatory action research, and pragmatism, adopted mainly in multimethod and mixed method studies (Creswell & Plano Clark, 2007).

As an emerging paradigm, transformativism directly tackles the politics in research and confronts social oppression. Transformative researchers criticise both postpositivist assumptions for imposing structural laws and theories that do not fit marginalized groups and constructivist conventions for not going far enough to address issues of power, discrimination, and social justice (Creswell, 2014; Mertens, 2010). The transformative paradigm recognizes multiple versions of reality, but in contrast to the constructivist viewpoint, it does not deem every version of reality as legitimate. Instead, it holds that in the construction of reality there are several factors of social, political, cultural, economic, ethnic, gender, and disability-related nature that give privilege to one version of reality over another, and what is taken for "real" might seem "real" only because of historically reified structures (Mertens, 2010). From a methodological perspective, transformativism is pluralistic and evolving, with the common theme of the inclusion of marginalized and oppressed voices (Chilisa, 2012; Creswell, 2014; Mertens, 2010).

Finally, the pragmatic paradigm as the most recent addition to the social science research provides a new philosophical framework for inquiry. Researchers embracing this paradigm do not commit to any one system of philosophy and reality, putting aside the ontological and epistemological debate about what and how the social world can be known (Johnson & Onwuegbuzie, 2004). Instead pragmatists focus on what works as the truth regarding the research problem under investigation, which can thus be approached from postpositivist or constructivist perspectives or both, and use pluralistic approaches to derive knowledge about it (Creswell, 2014; Morgan, 2007; Patton, 2002). Researchers thus can focus on how to best address the research problem rather than comparing the strengths and limitations of quantitative and qualitative approaches. Thus, research questions in the pragmatist approach are not considered inherently important, neither are methods automatically appropriate. Instead, the researcher decides what is important and what is appropriate for the problem under investigation (Morgan, 2007). This way pragmatism opens the door for multiple methods, different worldviews, different

assumptions as well as different forms of data collection to derive knowledge about a selected research problem deemed important by the researcher while a sufficient degree of mutual understanding with people who read and review the product of research has to be achieved (Creswell, 2014; Tashakkori & Teddlie, 1998).

The four major paradigms and their implications for the practice of research are summarised along the paradigm-defining aspect in the following *Figure 5*. While each paradigm can be conceptualized as distinct, the lines between them are fuzzy and negotiable reflecting the fluid nature of current research practice which emphasises the need to move between worldviews to answer research questions (Creswell, 2014; Mertens, 2010). Still, since paradigms guide thinking and practice, researchers should be able to identify the one which most closely approximates their own (Mertens, 2010).

	Postpositivism	Constructivism	Transformativism	Pragmatism
Ontology (Nature of reality)	Singular reality knowable within a level of probability	Multiple, socially constructed realities	Political realities	Singular and/or multiple realities
Epistemology (Nature of knowledge)	Objective, stable and generalizable	Transactional, subjectivist	Critical subjectivity in participatory transaction	Practicability
Axiology (Role of values)	Value free, neutral	Value-bound, value-laden	Negotiated	Multiple stances
Ontology (Nature of reality)	Quantitative methods (primarily); deductive, interventionist, decontextualized	Qualitative methods (primarily); inductive, hermeneutical, dialectical, contextual	Qualitative, quantitative and mixed methods, participatory, contextual with focus on historical factors related to oppression	Qualitative and/or quantitative; multiple stances

Figure 5. Basic assumptions associated with major paradigms in social research. Based on Creswell & Plano Clark (2007), Lincoln & Guba (1994), Mertens (2010)

With paradigms discussed, the next section outlines the key elements of the pragmatic paradigm in relation with the present thesis.

3.1.2 Identified research paradigm: Pragmatism

The pragmatic paradigm puts aside ontological and epistemological debates about truth and reality and places the research question at the heart of the inquiry process also recognising the value of using different, but complementary strategies to answer it

(Johnson & Onwuegbuzie, 2004). The pragmatic paradigm was adopted in the present thesis because its philosophical and methodological pluralisms allowed me to make choices about the study design as well as the research process based on what works best for answering the research question on the relationships between creativity, learning, technology.

The pragmatist paradigm also accommodated my pluralistic view on the nature of reality. From an ontological perspective, pragmatic researchers have no problem with recognizing the existence of both the natural word and that of the emergent social and psychological one which includes language, culture, human institutions, and subjective thoughts (Johnson & Onwuegbuzie, 2004, p.18). Truth is what works at a time obtained through experience and experimenting in research, it is provisional and instrumental with some estimates being more accurate than others (Johnson & Onwuegbuzie, 2004).

I welcome the pragmatists' effort to replace epistemology with practicality (Creswell & Plano Clark, 2007). In the pragmatist perspective knowledge is viewed both based on the reality of the word we experience and live in as well as constructed by the human mind. Knowledge is considered tentative in that the inquiry is thought to provide the best answers that currently can be mustered (Johnson & Onwuegbuzie, 2004). Furthermore, the relationship between the known and to be known in research is determined by what the researcher considers as appropriate to the study at hand (Mertens, 2010). Rather than positioning themselves as distant observers, relational researchers, or socially and historically contextualized inquirers, pragmatists are free to study what interests them and is of value to them, in the different ways they deem appropriate, and use the results in ways that can bring about positive consequences within their value system (Mertens, 2010; Tashakkori & Teddlie, 1998, p. 30).

Central to the pragmatic approach is to gain knowledge in the pursuit of desired ends as influenced by the researcher values and politics (Morgan, 2007). Values are acknowledged to be common component of the research process that needs to be explicitly and reflectively stated (Creswell & Plano Clark, 2007, p.24). The values underpinning the present study include those I hold about creativity, technology, learning, and education research. These values have been shaped by my personal experience both as a secondary school teacher promoting the effective use of educational technology in the classroom and as an education researcher investigating creativity, technology, and learning.

As a practitioner and award-winning educational technology integrator, member of national, and international teacher communities focusing on technology in education, I applied and encountered various uses of technology for learning. Reflecting on my own and other teachers' practices, I realized that technology can be a powerful learning tool. Technology use in education, however, may be driven by misconceptions (e.g. the myth of digital natives or multitasking) and political agenda (e.g. shaped by policy makers or large technological companies) often resulting in practices that integrate digital tools in ineffective ways. Furthermore, I have also noticed that technology uses that support active student-centred learning involve both teachers' and students' creativity. At the same time, aligning curriculum, creativity, and technology seemed to pose challenges to teachers in many schools in Hungary and abroad.

In my capacity as a researcher, I found that creativity and technology-integration research rarely turns towards exemplary teachers (Andiliou & Murphy, 2010; Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2016). I also experienced a disconnect between research and practice, finding that many research themes and results have often been less relevant to the classroom practice. I believe that educational research should align more closely with the realities of the classroom, educational researchers should actively seek teachers' input and value their expertise.

Pragmatism holds that research occurs in social, historical, political, and other contexts, and contemporary researchers working within the pragmatic paradigm are also reflective of social justice and political aims (Creswell, 2014). My personal goal with the present study is improving teaching and learning in schools. I believe that teachers have a wealth of knowledge about what works in the classroom, yet research in Hungarian context rarely builds on teachers' classroom experience. Educational researchers, therefore, should actively communicate and collaborate with classroom teachers to make their voices heard, so that learners could benefit from research-based teaching practices grounded in the realities of the classroom.

Finally, the pragmatist approach endorses eclecticism and pluralism in methodology: both qualitative and quantitative methods are compatible with the pragmatic paradigm (Morgan, 2007). Pragmatists argue that observation, experience and experiments are all useful ways to gain understanding of people and the world, and that methods or the combination of methods should be chosen based on what works best for answering the research questions (Creswell, 2014; Johnson Johnson & Onwuegbuzie,

2004; Maxcy, 2003; Patton, 2002). It is common for multimethod and mixed methods researchers to adopt a pragmatic approach (Bryman, 2008). The present study conducted in the pragmatic paradigm applied a qualitatively driven multimethod research design to explore teachers' beliefs about and experiences with nurturing student creativity in technology-integrated learning environments with the aim of generating themes and questions for future research on creativity, learning and technology grounded in the realities of the classroom as well as to support policy, teacher education, and practice in the area of technology-enhanced creativity education. Details of the design and its appropriateness for the research question are discussed in the following Section 3.2.

3.2 RESEARCH DESIGN: QUALITATIVELY-DRIVEN MULTIMETHOD RESEARCH

Pragmatist researchers often use multimethod designs in their inquiry since the combination of different research strategies allows them obtain a more complex picture of human behaviour and experience (Bryman, 2008; Moorse, 2003). A multimethod design has been defined as a series of complete related qualitative and/or quantitative studies with different research questions, which, however are complementary to the overall aim of the research (Morse & Niehaus, 2009). In contrast to mixed method designs, which include one complete and one supplemental study interpretable only within the context of the core component, the studies conducted within the multimethod research are relatively complete in their own (Morse & Niehaus, 2009). With multimethod projects, it is the results of the applied methods that inform the emerging conceptual scheme as the investigator addresses the main research question (Morse, 2003).

Multimethod designs may be of different types: for example, simultaneous or sequential, qualitatively or quantitatively driven (Morse & Niehaus, 2009). In simultaneous designs the various methods applied are used concurrently: one method forms the basis of the emerging theoretical scheme, while the second is planned to elicit information that the first method cannot achieve. In sequential multimethod designs, the base study is conducted first while the second method is planned to resolve problems and issues uncovered by the first one or to provide a logical extension to its findings. In addition, research implementing multimethod design may be either quantitatively or qualitatively driven. Qualitatively driven multimethod projects have an inductive drive

and are used for developing description or deriving meaning of a phenomena. Quantitatively driven multimethod designs, deductive in nature, are used primarily for hypotheses or theory testing (Morse, 2003; Morse & Niehaus, 2009).

The present dissertation adopted a qualitatively-driven sequential multimethod approach to research. The overall aim of the research was to explore teachers' beliefs about and experience with nurturing student creativity in technology-integrated learning environments to generate themes and questions for future research on creativity, learning, and technology grounded in the realities of the classroom as well as to support policy, teacher education, and practice in the area of technology-enhanced creativity education. The overarching research questions guiding this study were the following:

> *What characterizes teachers' beliefs about and experience with nurturing creativity using educational technology?*
>
> *How do teachers' beliefs and experience relate to the existing empirical evidence on creativity, learning, and technology*?

Given its complex nature, the topic of nurturing creativity through digital technology in education lent itself to applying a multimethod approach to research, which allowed a more thorough and comprehensive investigation of the phenomena. The scarcity of literature on the effects of technology on students' creativity highlighted in the literature review section of the present dissertation determined the theoretical drive: since the purpose of the project was to explore a phenomenon, rather than test a theory or hypotheses, a qualitative, inductive drive was seen appropriate. Finally, the design was sequential: first, a systematic literature review was conducted to determine the nature of teacher' beliefs and experience with nurturing creativity both offline and in technology-integrated learning environments in the recent empirical research base (Study 1), followed by a qualitatively driven multiple case studies (Study 2) to resolve the issues uncovered by the systematic review and to provide a logical extension to it. Thus, the purpose of Study 2 was to further explore teachers' beliefs and experience with the digital technologies to promote creativity by investigating the phenomena across the secondary school curriculum. The following *Figure 6* provides a graphic overview of the qualitatively-driven multimethod research design applied in the present dissertation,

including the overall aim of the research, as well as the aims, methodologies and research questions of its individual components.

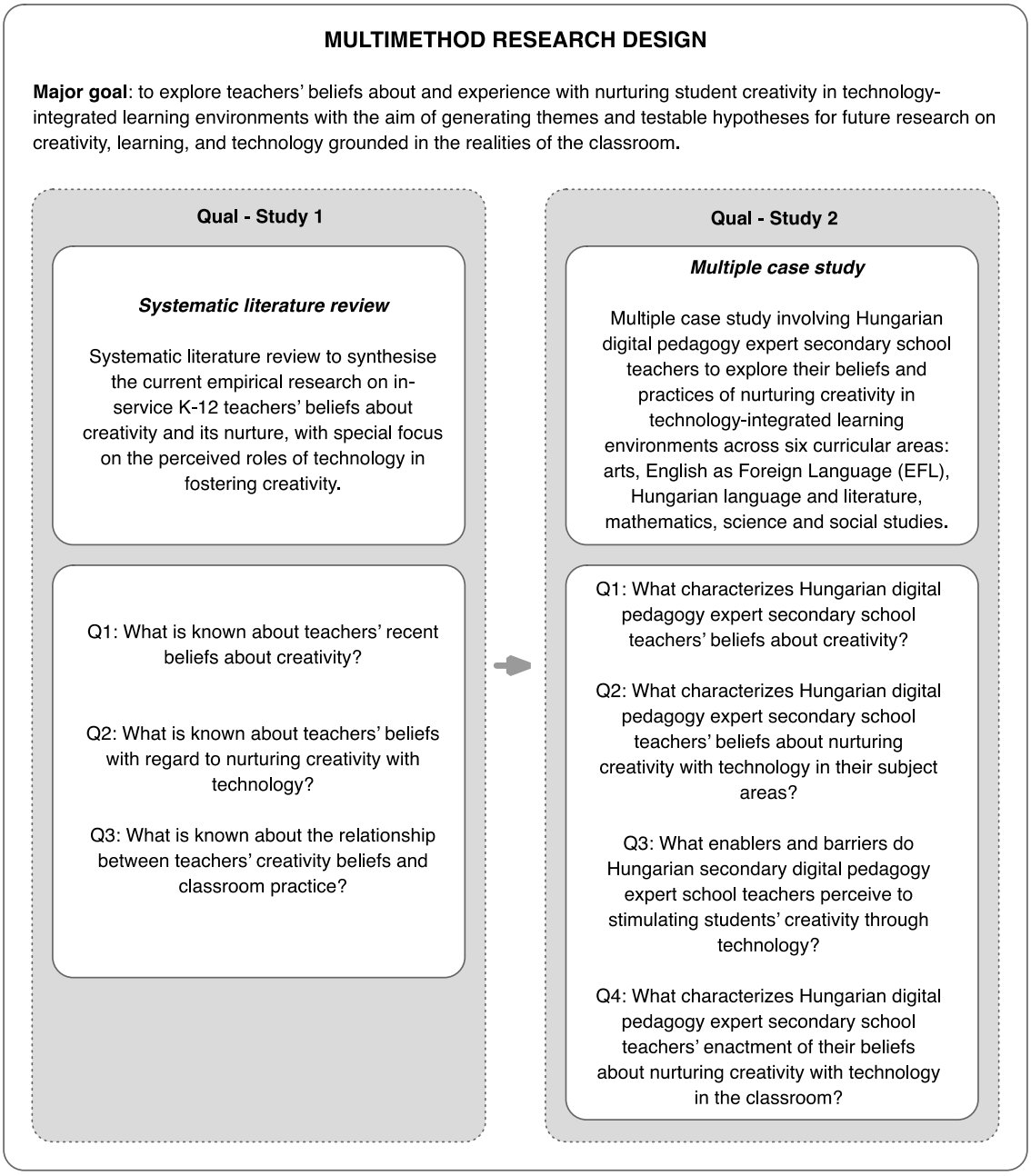


Figure 6. Graphic overview of the qualitatively-driven multimethod research design implemented in the dissertation

As *Figure 6* shows, to implement the selected design two interdependent studies were conducted. The methodology, findings, discussions, and conclusions of these studies will be presented separately in Chapter 4 and Chapter 5, while the overall conclusions and implications of the multimethod investigation presented in this dissertation will be presented in the final Chapter 6.

Chapter 4: Study 1 – A Systematic Literature Review of Teachers' Beliefs[3]

4.1 INTRODUCTION

The purpose of Study 1 was to describe, appraise and synthesize the most rigorously available current empirical research base on in-service K-12 teachers' beliefs about creativity and its nurture with special focus to the perceived roles of technology in fostering creativity. Study 1 sought to answer the following research questions:

Q1: What is known about teachers' recent beliefs about creativity?

Q2: What is known about teachers' beliefs with regard to nurturing creativity with technology?

Q3: What is known about the relationship between teachers' creativity beliefs and classroom practices?

Study 1 applied a systematic literature approach to answer the research questions and drew data from a systematically identified empirical evidence base consisting of 53 studies published between 2010-2015 on teachers' beliefs about creativity and its nurture.

Chapter 4 presents Study 1. It first discusses the systematic review methodology applied to answer the research questions posed (Section 4.2) and describes the findings that emerged from the methodological procedures (Section 4.3). Findings are then discussed and interpreted in relation to the existing body of literature on creativity, technology, learning, and teachers' beliefs and practices (Section 4.4). Chapter 4 ends with the conclusions drawn from Study 1 (Section 4.5), and its implications for the subsequent Study 2 (Section 4.6).

[3] Parts of Chapter 4 were published in Bereczki and Kárpáti (2018). The sections featured in the dissertation represent my own work.

4.2 SYSTEMATIC LITERATURE REVIEW METHODOLOGY

Study 1 of the qualitatively multimethod investigation presented in this dissertation was a systematic literature review conducted to explore teacher' beliefs and experiences with nurturing creativity both in offline and in technology-integrated learning environments based on the recent empirical research base. This section presents the methodology applied in Study 1. First, the systematic literature review method adopted and the procedures applied during the review process will be described, including eligibility criteria and search strategy adopted, details of the quality appraisal process of the identified studies, description of the data extraction and analysis procedures (Section 4.2.1). Third, the characteristics of the final sample of studies included in the review will be presented (Section 4.2.2), which is followed by the description of the ethical considerations (Section 4.2.3) pertinent to Study 1. This section ends with a summary of the sections describing the research methodology applied in Study 1 (Section 2.4.5)

4.2.1 Systematic literature review approach

A systematic review is a research method that is undertaken to review research literature, using systematic and rigorous methods (Gough, Oliver, & Thomas, 2012). For the present study, systematic literature has been defined as:

> A review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from the studies that are included in the review. Statistical methods (meta-analysis) may or may not be used to analyse and summarise the results of the included studies. (The Cochrane Collaboration, 2005).

Systematic reviews are often referred to as 'original empirical research' because they review primary data (Aveyard & Sharp, 2011). They can be quantitative using statistical methods to combine data from multiple studies (meta-analysis), or qualitative (synthesis) in which findings are summarized and synthetized using qualitative methodology (Gough et. al., 2012). There are two broad types of qualitative synthesis. First, integrated reviews, aggregate or summarise data using themes, while interpretative reviews involve interpreting the data using an inductive approach from which new conceptual understandings can emerge (Gough & Thomas, 2012).

In Study 1 a qualitative systematic literature review, more specifically a thematic synthesis, was chosen to describe, appraise and synthesize the current empirical research on in-service K-12 teachers' beliefs about creativity and its nurture, given its methodological strength as a means of establishing a comprehensive and reliable evidence base (Gough et al., 2012, p. 2). To ensure that the review was systematic, Study 1 was guided by the Preferred Items for Systematic Reviews and MetaAnalysis (PRISMA) statement (Moher, Liberati, Tetzlaff, Altman, & ThePrismaGroup, 2009), and included the following steps: (1) defining relevant studies and establishing inclusion/exclusion criteria; (2) developing the search strategy; (3) identifying potential studies through searching and screening; (4) describing and appraising included studies; (5) analysing and synthesizing findings.

Eligibility criteria

Eligibility criteria for the present review were the following:

- Topic of research: studies designed to describe and explore teachers' beliefs about creativity, creative students, and creative pedagogy (creative teaching, teaching for creativity, creative learning).
- Type of research: full primary reports of empirical research (qualitative, quantitative, and mixed method).
- Study population and settings: research whose primary participants were in-service teachers active in K-12 education settings.
- Date of publication: studies published between January 2010 and December 2015
- Language of publication: studies written in English.
- Transparency: studies which explicitly described the theory, methodology, and data on which conclusions rest.
- Reliability/validity: studies whose findings are valid and reliable, considering the type of study.

Exclusion criteria were the following:

- Studies that contained incidental data on K-12 teachers' beliefs about creativity.

- Studies that collected data in gifted, early childhood and tertiary education settings.
- Studies whose findings on K-12 teachers' beliefs about creativity could not be separated from those of other populations', such as teachers active in gifted, early-childhood, tertiary education settings, or students, parents, head teachers, and other stakeholders.

Search strategy

To locate as much of the potentially relevant literature on teachers' beliefs about creativity published between 2010-2015 as possible, I searched different sources between February and April 2016, presented in detail below.

Electronic databases searched in this review included those relevant to education, educational psychology and psychology: ProQuest ERIC, EBSCO PsychInfo. In addition, I searched ProQuest Dissertation and Theses Global for dissertations on the topic in English accepted for higher degrees (PhD, EdD). Search terms developed for database search included belief terms, creativity terms and teacher terms, which were established upon a preliminary review of the literature and on the previous synthesis of the research on teachers' conceptualizations of creativity between 1991-2010 by Andiliou and Murphy (2010). Pilot searches on single and combined terms were also carried out before deciding on a final list of keywords, which are presented in *Figure* 7.

To avoid limitations of using pre-determined search terms and controlled vocabulary (Brunton, Stansfield, & Thomas, 2012), hand searches were made for the period between 2010-2015 of the following key journals: *Creativity Research Journal, Journal of Creative Behavior, Journal of Psychology Aesthetics, Creativity and the Arts, Thinking Skills and Creativity, International Journal of Creativity and Problem Solving*. Further searches included the forward reference list checking of key articles on the topic using Google Scholar, i.e. those published by Aljughaiman and Mowrer-Reynolds (2005), Andiliou and Murphy (2010), Fryer and Collings (1991), Runco and Johnson (2002) and Westby and Dawson (1995) as well as the reference list checking of studies included in the present review. Finally, I searched Google for further hits and asked personal and professional contacts.

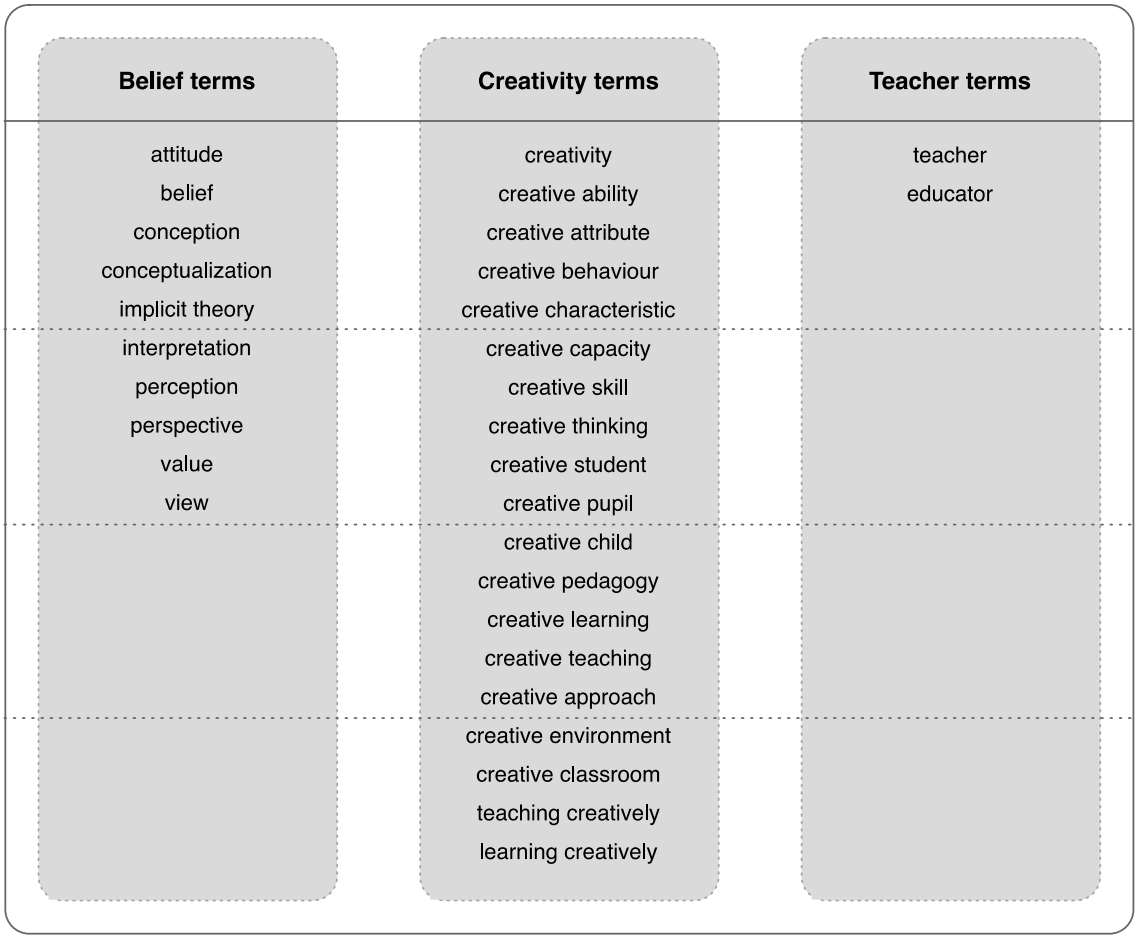


Figure 7. Keywords identified for database search in Study 1

Study selection

The database search delivered 2,600 references. After removing 387 duplicates, titles and abstracts of the remaining 2,213 articles were divided between my advisor and me, and screened individually for preselection purposes using the inclusion and exclusion criteria. A random sample of 10% percent of the articles were chosen and screened by both of us. Interrater reliability was calculated for the sample showing almost perfect agreement (Kappa= 0.951). Screening thus produced 61 studies, the full texts of which were acquired to be checked applying the inclusion/exclusion criteria. Discrepancies were solved by discussion until 100% agreement was reached.

Of the 61 studies resulting from the database search, 12 have been excluded based on the inclusion/exclusion criteria. Hand searching produced 28 additional studies, of which a further seven have been excluded with reason. Finally, the search strategy applied yielded a sample of n=70 studies which were then judged for their quality and relevance.

Quality and relevance appraisal

After judging pre-selected studies according to the inclusion/exclusion criteria, the remaining 70 studies were assessed for their quality and relevance based on the Weight of Evidence (WoE) framework outlined by Gough (2007). Following this framework, studies were appraised in relation to three key areas: methodological quality (WoE A), methodological relevance and topic relevance (WoE C). For more details, see the scoring sheet produced to aid the appraisal process presented in Appendix A. For a graphic overview of the selection procedure see *Figure 8*.

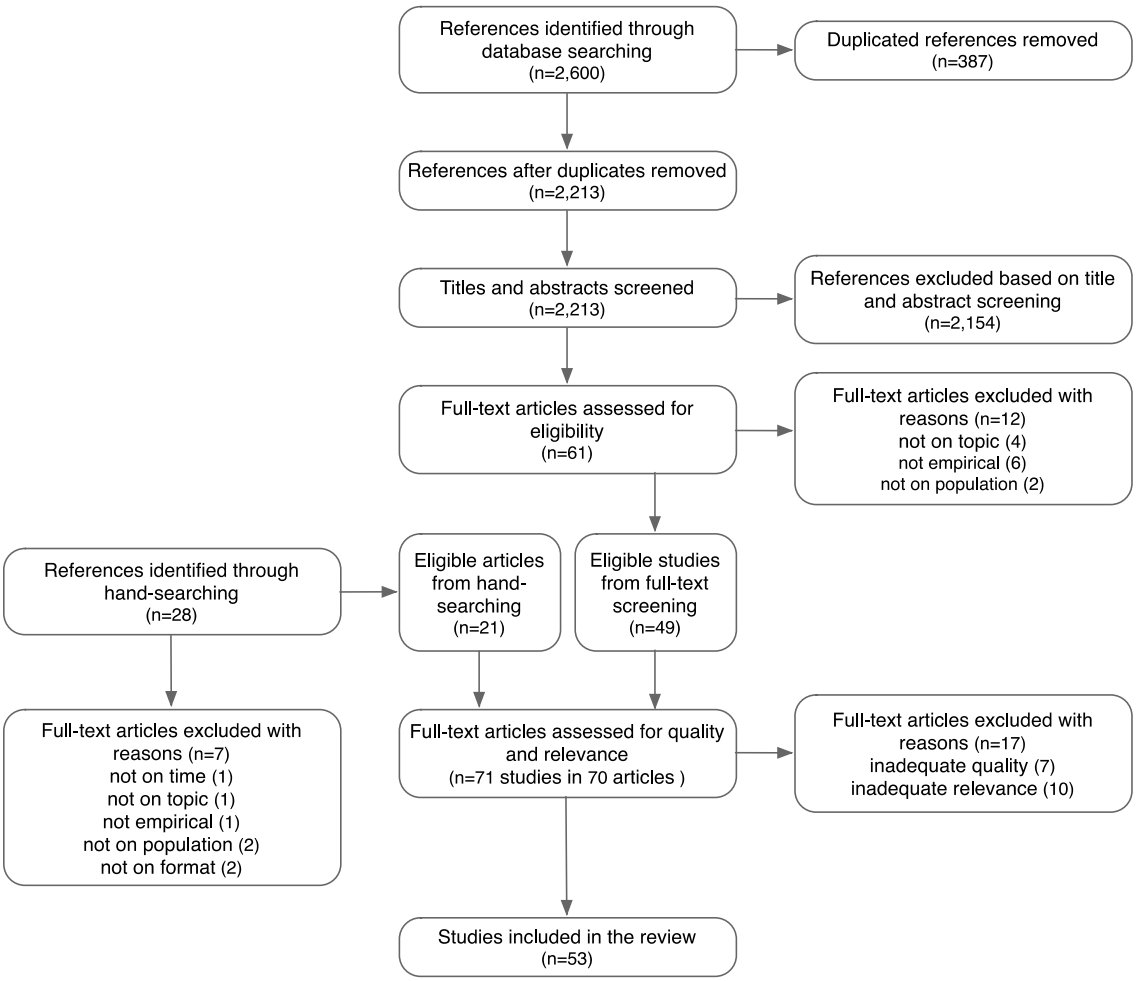


Figure 8. PRISMA Flow Diagram of study selection for the systematic review in Study 1

The appraisal of studies was undertaken by me while another educational researcher with a PhD assessed a random selection of studies (25%, n=15 of the 60 studies included in the final pool). The two judges reached full agreement on the quality and relevance ratings awarded to the sample.

Studies considered inadequate in any area, as well as studies rated low in the methodological quality area were excluded from the review. The appraisal of pre-selected studies, thus resulted in the exclusion of further 18, which based on their weight of evidence were considered inadequate for the present review: seven studies did not meet the quality criteria, whereas eleven did not satisfy the topic relevance criteria. For the rest of the studies the results of the methodological quality, methodological relevance and topic relevance appraisal were combined and given an overall weight of evidence of high, medium or low. The results of the quality appraisal of the included studies are provided in Appendix A.

The search and appraisal strategy applied yielded a final sample of n=53 studies as presented by *Figure 8*.

Data extraction and analyses

Data extraction from the 53 selected studies was conducted using a template which recorded key information about the sample: (1) authors, (2) year of publication, (3) type of publication, (4) study purpose, (5) research questions/hypotheses, (4) type of view examined, (3) view topic, (4) country, (5) grade level, (6) subject area, (7) sample characteristics, (8) research design, (9) research instruments, (10) data analysis procedures, (11) major findings, (12) summary of major findings, (14) creativity definitions.

Surface characteristics of the reviewed studies were analysed using descriptive statistics. For the synthesis of findings in relation to the first research question, which focused on the characteristics of teachers' beliefs about creativity, we applied mixed-coding strategy with some pre-defined concepts (Oliver & Sutcliffe, 2012) building on Andiliou and Murphy's (2010) conceptual framework on the topic. For the questions concerning teachers' beliefs and perceptions in relation to classroom practice and the factors that might influence teacher' views about creativity, data was open-coded (Oliver & Sutcliffe, 2012). Coding in both cases was carried out in NVivo 11 for Mac, while themes as well as the decisions taken regarding these were discussed with my advisor.

4.2.2 Characteristics of included studies

In total 53 studies met the eligibility criteria and were included in the review (see Appendix B). For a summary of the surface characteristics see *Figure 9*.

The majority of studies were published as journal articles (n=37), over a quarter were dissertations (n=15) and only one study was reported in another format, as a research report. The retrieved studies were undertaken around the world: in North America (n=16), in Asia (n=14), Europe (n=16) and Australia (n=2). Five studies examined teachers' creativity-related beliefs across different cultural settings (Cachia & Ferrari, 2010; Hartley & Plucker, 2014; Hong & Kang, 2010; Leikin, Subotnik, Pitta-Pantazi, Singer, & Pelczer, 2013; Zhou, Shen, Wang, Neber, & Johji, 2013).

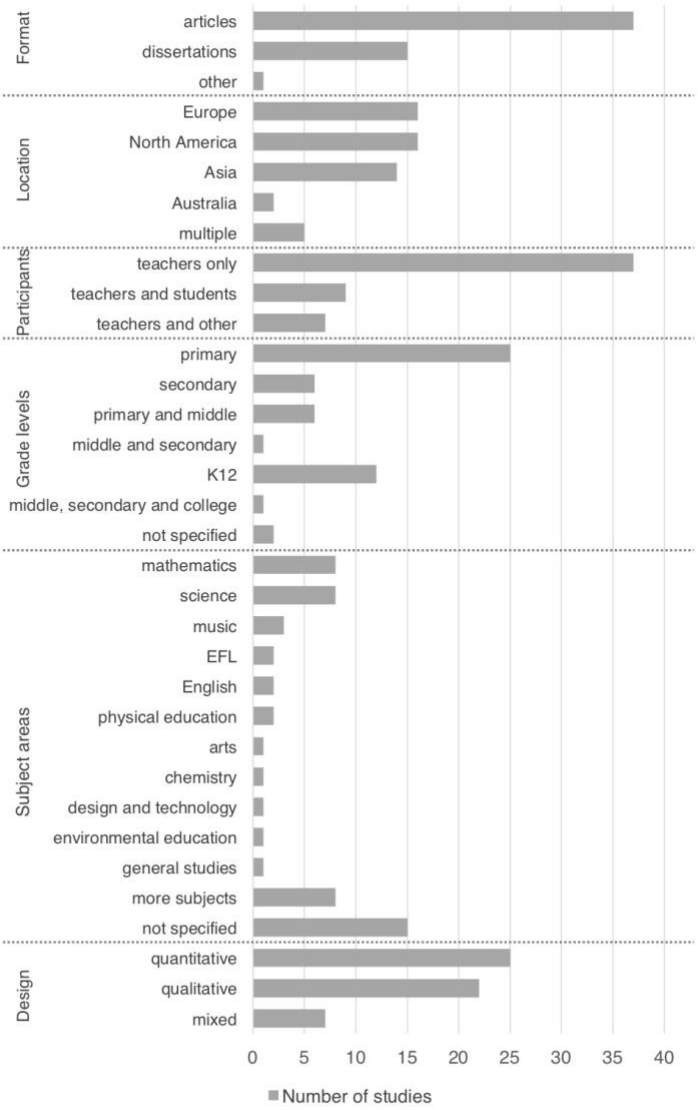


Figure 9. Summary of the surface characteristics of the reviewed studies in Study 1

The included studies sampled in-service K-12 teachers either exclusively or along with other groups of participants. More than half of the studies (n=37) examined teachers' creativity-related views focusing solely on in-service teachers, while others also sampled senior (Alkhars, 2013), gifted education (Chan & Yuen, 2014) or pre-service teachers (Levenson, 2013; Turner, 2013). A significant number of studies (n=10) recruited teachers together with their students (Alsahou, 2015; Beghetto, Kaufman, & Baxter, 2011; Gralewski & Karwowski, 2013; Hartley, 2015; Hoff & Carlsson, 2011; Lasky & Yoon, 2011; McLellan & Nicholl, 2012; Shaheen, 2011; Turner, 2013; Urhahne, 2011). Teachers views regarding creativity were also explored along with those of school principals (Al-Nouh, Abdul-Kareem, & Taqi, 2014), and psychologists and mathematicians (Dickman, 2014).

Across the studies reviewed, sample sizes ranged from single teacher respondents to 7,650, from first-year teachers to teachers with more than 40 years of professional experience from urban, small-town and rural schools, holding different degrees (BA, MA, PhD), trained or untrained in teaching for creativity.

About half of the reviewed studies (n=25, 47%) investigated elementary teachers' views about creativity (kindergarten to grade 6) whereas far fewer (n=6, 11%) focused on secondary teachers' (grades 9-12). More than a third of the studies (n=20, 38%) sampled educators teaching at various levels, however, only six investigated similarities and differences between teachers' views across grade levels (Cachia & Ferrari, 2010; Snell, 2013; Stone, 2015; Tanggaard, 2011; Turner, 2013; Zbainos & Anastasopoulou, 2012). Furthermore, three studies did not specify the grade levels at which teachers from the sample taught (DaVia Rubenstein, McCoach, & Siegle, 2013; Karwowski, 2010, 2011).

More than half of the studies (57%, n=30) explored subject-specific views of creativity, whereas many (28%, n=15) did not indicate the participants' subject specialization. Several studies (15%, n=8) sampled educators teaching various subjects, however only two examined teachers' creativity-related views across more areas (Beghetto et al., 2011; Cachia & Ferrari, 2010)

The methodological approaches adopted within the selected studies varied. The number of quantitative and qualitative studies was similar: 25 studies used a quantitative and 22 a qualitative approach. In addition, seven studies applied mixed-method design. Of the 25 quantitative studies, 17 were mono-method using a teacher questionnaire in

descriptive, comparative or correlational designs. Seven studies combined teacher questionnaires with the analysis of student inventories, self-ratings, grades, creativity and/or ability tests (Beghetto et al., 2011; Gralewski & Karwowski, 2013; Hartley, 2015; Hoff & Carlsson, 2011; Karwowski, 2010; Urhahne, 2011). Qualitative studies employed phenomenological, grounded theory and case-study designs. Nine of the 22 studies studies collected data solely from teachers interviews, whereas 12 applied multiple methods such as individual interviews, focus groups, classroom observation, document and audio-visual material analysis.

A variety of belief-terms have been identified in the studies exploring teachers' beliefs about creativity, researchers often invoking various terminologies within the same article. Studies most often addressed teachers' perceptions (n=17), followed by beliefs (n=12) and conceptions (n=11).

29 of the 53 reviewed studies provided definitions of creativity in line with current theoretical conceptualizations according to which creativity requires both originality and appropriateness, and is situated in a given context. Less consistent with current research, many studies equated creativity with divergent thinking or elements of divergent thinking, such as fluency, flexibility, originality and elaboration (e.g. Fairfield, 2010; Lev-Zamir & Leikin, 2011, 2013; Levenson, 2015; Liu & Lin, 2014). Finally, eleven studies did not define creativity at all (e.g. Chan & Yuen, 2014; Konstantinidou, Michalopoulou, Agelousis, & Kourtesis, 2013; Pavlović, Maksić, & Bodroža, 2013).

4.2.3 Ethical considerations

The research did not involve working directly with teachers, nevertheless, ethical principles were still at the forefront, in that I only studies which described appropriate ethical practice were included in the review.

4.2.4 Section summary

This section aimed to describe the systematic literature review methodology adopted in the Study 1. The next section presents the findings that emerged from the analysis of data.

4.3 RESULTS

This section presents the results of the systematic literature review conducted to describe, appraise, and synthesize the most rigorously available current empirical research base on in-service K-12 teachers' beliefs about creativity and its nurture, with special focus to the perceived roles of technology in fostering creativity in Study 1. Results are structured along the three research questions asked by Study 1. Section 4.3.1 addresses findings pertaining to research sub-question **Q1:** What is known about teachers' recent beliefs about creativity? Section 4.3.2 describes findings in relation to research sub-question **Q2:** What is known about teachers' beliefs with regard to nurturing creativity with technology? Section 4.3.3 details findings with reference to research sub-question **Q3:** What is known about the relationship between teachers' creativity beliefs and classroom practices? This sections end with a summary (Section 4.3.4)

4.3.1 What is known about teachers' recent beliefs about creativity?

To synthesize findings of the 53 recent studies found on teachers' beliefs about creativity, the conceptual framework of 'Teachers' beliefs about creativity' put forward by Andiliou and Murphy (2010) has been adopted. The following Table 3 summarizes the themes and sub-themes identified in the current literature on teachers' beliefs about creativity and their occurrence in the reviewed studies.

As with the literature before 2010, recent studies investigated teachers' creativity-related beliefs along three main themes: teachers' beliefs about the nature of creativity, beliefs about the profile and characteristics of creative individuals, and beliefs about the creativity-fostering classroom environment, as well as along several subthemes connected to these. While many subthemes were consistent in the literature before and after 2010, new sub-themes, such as teachers' beliefs about creativity in teachers and in teaching, also emerged in the research body of recent years.

Table 3. Themes in the current literature on teachers' beliefs about creativity and their occurrence in the reviewed studies in Study 1

	Nature of creativity				**Creative individuals**		**Creativity-fostering classroom environments**			
	Distribution	*Malleability*	*Domain-specificity*	*Context of reference*	*Creative student*	*Creative teacher*	*Teachers' attitudes*	*Creative teaching*	*Teaching for creativity*	*Barriers and enablers*
Adams (2013)	✓			✓			✓		✓	✓
Aish (2013)	✓	✓	✓	✓	✓		✓		✓	✓
Al-Nouh, Abdul-Kareem, & Taqi (2014)		✓					✓			✓
AlKhars (2013)						✓		✓		
Alsahou (2015)	✓			✓					✓	✓
Beghetto, Kaufman, & Baxter (2011)					✓					
Bryant (2014)			✓	✓						
Cachia & Ferrari (2010)	✓	✓	✓	✓			✓			✓
Chan & Yuen (2014)							✓			
Cheng (2010)										✓
Daskolia, Dimos, & Kampylis (2011)				✓					✓	
DaVia Rubenstein, McCoach, & Siegle (2013)	✓						✓			
Dickman (2014)									✓	
Fairfield (2010)	✓	✓					✓		✓	✓
Frawley (2014)										✓
Gralewski & Karwowski (2013)					✓					
Hartley & Plucker (2014)									✓	✓
Hartley (2015) manuscript 2					✓					
Hartley (2015) manuscript 3							✓		✓	
Henriksen & Mishra (2015)	✓			✓		✓		✓		
Hoff & Carlsson (2011)					✓					
Hondzel (2013)	✓				✓		✓		✓	✓
Hong & Kang (2010)	✓	✓		✓					✓	✓
Huang & Lee (2015)								✓		
Kampylis, Saarilouma, & Berki (2011)										✓

Table 3 (*continued*)

	Nature of creativity				**Creative individuals**		**Creativity-fostering classroom environments**			
	Distribution	*Malleability*	*Domain-specificity*	*Context of reference*	*Creative student*	*Creative teacher*	*Teachers' attitudes*	*Creative teaching*	*Teaching for creativity*	*Barriers and enablers*
Karwowski (2010)					✓					
Konstantinidou et al. (2013)				✓	✓					
Konstantinidou et al. (2014)	✓	✓					✓		✓	
Lasky & Yoon (2011)	✓			✓						
Leikin et al. (2013)					✓	✓				
Lev-Zamir & Leikin (2011)									✓	
Lev-Zamir & Leikin (2013)						✓		✓		
Levenson (2013)									✓	
Levenson (2015)				✓					✓	
Liu & Lin (2014)				✓	✓				✓	
McLellan & Nicholl (2013)							✓			
Merriman (2015)						✓		✓		✓
Meyer & Lederman (2013)							✓		✓	
Myhill & Wilson (2013)	✓	✓								
Newton & Newton (2010)									✓	
Olivant (2015)										✓
Pavlović, Maksić & Bodroža (2013)	✓				✓					
Scott (2015)	✓		✓	✓			✓		✓	✓
Shaheen (2011)					✓		✓			✓
Shen (2014)									✓	✓
Snell (2012)									✓	✓
Stone (2015)				✓	✓				✓	
Tanggaard (2011)									✓	
Tomasevic & Trivic (2014)	✓	✓							✓	✓
Turner (2013)	✓	✓					✓	✓	✓	
Urhahne (2011)					✓					
Zbainos & Anastasopoulou (2012)	✓	✓					✓			
Zhou et al. (2013)	✓	✓	✓	✓	✓					✓

Teachers' beliefs about the nature of creativity

26 studies addressed teacher' beliefs about the nature of creativity either exclusively, or along with their views on creative individuals and creative classroom environment. Studies addressing creativity as a construct focused on teachers' beliefs about the distribution of creativity, its malleability, specificity and context of reference. Findings on teachers' beliefs concerning these aspects are detailed below.

Malleability – Creativity can be taught to a certain extent

The malleability of creativity was the focus of eleven studies. Across most of these studies, teachers strongly supported the idea that creativity can be enhanced (Aish, 2014; Al-Nouh et al., 2014; Cachia & Ferrari, 2010; Fairfield, 2010; Hong & Kang, 2010; Konstantinidou et al., 2014; Tomasevic & Trivic, 2014; Turner, 2013; Zhou et al., 2013). Some studies highlighted a positive relationship between teachers' views on the universality of creativity and malleability. Cachia and Ferrari (2010) found that the more participants believed that everyone can be creative, the more they agreed that creativity can be taught. The two teacher samples that considered creativity to be innate also held the general belief that it cannot be taught (Myhill & Wilson, 2013; Zbainos & Anastasopoulou, 2012). Similarly, in the cross-cultural study conducted by Zhou et al. (2013) Japanese teachers were to a lesser extent convinced about the plasticity of creativity than universality.

Domain specificity – Creativity can manifest in any domain to some extent

Teachers' views about the domain-specificity of creativity were explored in five studies. Across these studies, teachers generally supported the view that creativity can manifest in every domain of knowledge and can be applied to any discipline (Aish, 2014; Bryant, 2014; Cachia & Ferrari, 2010; Scott, 2015; Zhou et al., 2013). However, with the exception of Scott (2015) whose sample consisted of highly accomplished teachers all viewing creativity as integral to every discipline, teachers in the other four studies showed a slight bias towards certain subject areas. For example, bias towards arts-related subjects was found in four studies (Aish, 2014; Bryant, 2014; Cachia & Ferrari, 2010; Zhou et al., 2013) and science (Zhou et al., 2013). Furthermore, cross-cultural differences between teachers views about the domain-specificity of creativity were also revealed. In a study conducted among teachers from China, Germany and Japan, Zhou et al. (2013) found that Chinese teachers believed creativity to be less likely exhibited in literature, German

teachers in mathematics, while social sciences were considered a subject area in which creativity could least be manifested across all three countries.

Finally, several other studies exploring teachers' views about creativity in subject-specific contexts showed that teachers acknowledged the role of creativity in the specific subject areas they taught (Alsahou, 2015; Daskolia, Dimos, & Kampylis, 2012; Fairfield, 2010; Konstantinidou et al., 2014; Meyer & Lederman, 2013; Tomasevic & Trivic, 2014).

Context of reference – Creativity means originality, rarely appropriateness

Determining teachers' beliefs about what constitutes creative outcomes was the focus of 14 studies. Across ten studies, teachers emphasized originality, novelty or uniqueness as criteria for judging creative products, with only a few considering appropriateness, usefulness and value to be necessary for creativity (Adams, 2013; Aish, 2014; Alsahou, 2015; Bryant, 2014; Cachia & Ferrari, 2010; Hong & Kang, 2010; Levenson, 2013; Liu & Lin, 2014; Stone, 2015; Zhou et al., 2013), their views thus being in misalignment with the scientific theories of creativity. In addition, two studies highlighted a degree of uncertainty in teachers' judgements of novelty, educators being unsure about whom student outcomes should be novel to (Daskolia et al., 2012; Konstantinidou et al., 2013). Other dimensions of creative products were: practicality in the context of engineering and design (Lasky & Yoon, 2011) and environmental education (Daskolia et al., 2012), and ethicality in environmental education (Daskolia et al., 2012), which suggest domain-specific views in evaluating creative products. Furthermore, the requirement of creative products to be artistic appeared in four studies. Three provided further evidence for teachers' misconception that creativity can manifest itself mainly in arts (Adams, 2013; Aish, 2014; Daskolia et al., 2012), whereas in the third, artistry as a criterion for judging creative products could be justified by the nature of the domain of engineering and design in which the study was conducted (Lasky & Yoon, 2011). Exploring accomplished teachers views about creativity, Henriksen and Mishra (2015) found that, in line with recent creativity research, both originality and appropriateness were considered necessary for creativity by all participants.

The two cross-cultural examinations of teachers' beliefs showed that the emphasis on novelty was not culturally dependent, since originality was stressed over appropriateness to the same extent across the samples from the various countries examined (Hong & Kang, 2010; Zhou et al., 2013). Ethicality, nevertheless, was found to be more emphasized by the South Korean teachers than their American counterparts in

Zhou et al. (2013), suggesting the presence of culturally-specific aspects in teachers' beliefs regarding creative products.

Teachers' beliefs about creative individuals

19 studies addressed teachers' beliefs about creative individuals. Studies either investigated teachers' beliefs about creative students or those about creative teachers, the latter being a new theme emerging from the literature since 2010.

Beliefs about creative students – Creative students are difficult to identify

15 studies sought to determine teachers' beliefs about creativity in students, either focusing on educators' beliefs about the profile of creative students, or their perceptions of creativity in students.

Studies examining teachers' beliefs about the characteristics of creative students revealed that though teachers held several views aligned with creativity research in certain dimensions, they also often overlooked important creative characteristics, or had inconsistent and inadequate views about student creativity. Furthermore, the specific aspects emphasized, overlooked or misunderstood by teachers varied considerably across the samples. For example, Greek primary physical education teachers' in their survey responses emphasized imagination, self-confidence, wide interests as creative characteristics, but overlooked divergent thinking, critical thinking, autonomy, and associated talent with creative students (Konstantinidou et al., 2013). In a study conducted by (Aish, 2014), US primary school teachers identified 'artistic' and 'original' as the top characteristics of creative students, while few of them recognized other important personal features, such as critical thinking, problem-solving or risk taking. Pakistani teachers valued originality, curiosity and knowledge most, while referring to rote memorization and the ability to follow orders as creativity-relevant student skills (Shaheen, 2011). Besides the differences, similarities were also found across the studies: some teachers often mistakenly associated creativity with talent (Aish, 2014; Hondzel, 2013; Konstantinidou et al., 2013; Pavlović et al., 2013) intelligence (Aish, 2014; Konstantinidou et al., 2013; Pavlović et al., 2013; Shaheen, 2011) and academic achievement (Konstantinidou et al., 2013; Shaheen, 2011). Furthermore, three studies indicated that teachers tended to recognize only positive traits of creative students (Aish, 2014; Pavlović et al., 2013; Shaheen, 2011).

Two cross-cultural comparative studies highlighted several differences and similarities in teachers' beliefs about the profile of the creative students across different countries (Leikin et al., 2013; Zhou et al., 2013). Further context-related variations, based for example on subjects and grade levels taught, were not explored in the literature. Yet, there were two qualitative studies, which offered insight into teachers' beliefs about creative students in the context of elementary science (Liu & Lin, 2014) and art (Stone, 2015). These studies suggested variations in teachers views across subject areas.

Current empirical literature also explored teachers' perceptions of creativity in their students, which was the focus of seven studies. Of these, five sought to determine the accuracy of teachers' judgements of student creativity (Gralewski & Karwowski, 2013; Hoff & Carlsson, 2011; Karwowski, 2010; Shaheen, 2011; Urhahne, 2011). Findings in this respect revealed that teachers had difficulties in recognizing creativity in their students', and that students' abilities (Gralewski & Karwowski, 2013; Hoff & Carlsson, 2011; Hong & Kang, 2010; Urhahne, 2011), traits (Gralewski & Karwowski, 2013; Shaheen, 2011), gender (Beghetto et al., 2011; Gralewski & Karwowski, 2013), and age (Hartley, 2015; Urhahne, 2011) could affect educators' perceptions. Two further studies investigated teachers' perceptions of students' creativity in relation to students' creative self-efficacy beliefs (Beghetto et al., 2011; Hartley, 2015). These studies showed that teachers' ratings of students' creativity were positively related to students' creative self-efficacy beliefs, suggesting either that teachers in these samples could more accurately appraise their students' creativity or that teachers' judgements may have an impact on students' self-efficacy beliefs.

Beliefs about creative teachers – Creative teachers foster creativity

In-service K-12 teacher' beliefs about creativity in teachers was a new theme emerging from the current empirical literature with five studies addressing the issue. Creative teachers were described in terms of personal characteristics, pedagogical and content knowledge, skills and abilities in four studies applying qualitative approaches to explore teachers' views (Alkhars, 2013; Henriksen & Mishra, 2015; Lev-Zamir & Leikin, 2013; Merriman, 2015). For example, primary EFL teachers viewed creative teachers as confident, determined, self-directed, open-minded, sociable, and empathetic, possessing native-like language skills and able to choose the appropriate material for the teaching context (Alkhars, 2013). Creative mathematics teachers were characterized by both mathematical and pedagogical flexibility and originality (Lev-Zamir & Leikin, 2013). In

both studies, teachers recognized a number of characteristics that are relevant for a creative teacher, while offering a somewhat narrow perspective on who might be one. Two phenomenological studies focusing on highly accomplished teachers' views found that teachers see personal life creativity as strongly associated with creativity in teaching, and teaching for creativity (Henriksen & Mishra, 2015; Merriman, 2015).

Finally, Leikin et al. (2013) in a survey study comparing secondary math teachers' beliefs about creative mathematics teachers found that teachers from different countries emphasized different characteristics of creative mathematics teachers. In addition, the most recognized creative teacher characteristics across the samples in Leikin and her colleagues' (2013) study were teachers' enjoyment of mathematics and valuing and eliciting student creativity. These findings, once again, reinforce the belief expressed by teachers in the studies by Henriksen and Mishra (2015) and Merriman (2015), that fostering students' creativity requires creative teachers.

Teachers' beliefs about the creativity-fostering classroom environment

The analysis of the recent empirical literature found that research on teachers' beliefs about the creative environment comprised the examination of educators' beliefs concerning the promotion of creativity, the strategies that promote creative pedagogy (both creativity in teaching and teaching for creativity), as well as their perceptions of the factors that either foster or hinder creativity in the classroom. Research evidence of the 38 studies found in these areas is presented in the following section.

Beliefs about the promotion of creativity – Teachers value creativity and believe they can foster it

Teachers attitudes towards creativity, their self-efficacy beliefs in promoting their students' creative capacities, and perceptions of fostering creativity in the classroom were the focus of 16 studies. Nine studies investigating teachers' attitudes towards creativity showed that K-12 in-service teachers greatly value creativity. Across these studies, there was a high consensus among participants that creativity is essential and important (Adams, 2013; Aish, 2014; Al-Nouh et al., 2014; Cachia & Ferrari, 2010; DaVia Rubenstein et al., 2013; Fairfield, 2010; Meyer & Lederman, 2013; Scott, 2015; Shaheen, 2011). Also, teachers expressed overall high levels of self-efficacy in promoting their students' creativity across the seven studies that addressed the issue of teachers' creativity fostering self-efficacy beliefs (Al-Nouh et al., 2014; DaVia Rubenstein et al., 2013;

Fairfield, 2010; Hartley, 2015; Konstantinidou et al., 2014; Turner, 2013; Zbainos & Anastasopoulou, 2012). Two studies found, however, that a considerable number of educators felt insecure about their capability of fostering creativity (Aish, 2014; Fairfield, 2010). Finally, three studies investigated teachers' perceptions of their creativity fostering practices. Teachers in the studies by Chan and Yuen (2014) and Hondzel (2013) reported high levels of creativity fostering behaviour. Exploring whether the climate in design and technology lessons was perceived as conducive for creativity by students and teachers, McLellan and Nicholl (2012) found that participant teachers felt that learning activities and tasks were challenging and meaningful and that they granted enough freedom to their students, however, students' responses revealed the opposite.

Beliefs about teaching creatively and teaching for creativity – Several known strategies, some insecurities

Teachers beliefs about creative teaching and teaching for creativity as main constituents of a creativity-promoting classroom environment were the focus of 18 studies, with creativity in teaching emerging as a new theme in the literature after 2010.

Six studies sought to determine teachers' beliefs about creativity in teaching. Though the contexts were significantly different research being conducted in both primary and secondary settings, across various subject areas, and in several countries, a series of common strategies connected to creative teaching emerged from teachers' responses (see Table 4).

In addition, teachers in two studies considered creative teaching a skill that can be learnt, one which does not require excellent teacher performance (Huang & Lee, 2015), thus teachers in these studies promoted a democratic view of creativity in teaching. Furthermore, creative teaching was often seen as necessary for fostering students' creativity (Henriksen & Mishra, 2015; Huang & Lee, 2015; Lev-Zamir & Leikin, 2013; Merriman, 2015), which is in line with the current literature (Lin, 2011).

Table 4. Teaching strategies viewed by teachers as connected to creative teaching in the literature in Study 1

Creative teaching strategies	Studies
Making learning more interesting	Huang & Lee, 2015; Lev-Zamir & Leikin, 2013
Using imaginative teaching approaches and methods	Alkhars, 2013; Huang & Lee, 2015; Turner, 2013
Teaching beyond the curriculum	Alkhars, 2013; Lev-Zamir & Leikin, 2013; Turner, 2013
Encouraging divergent thinking and offering students opportunities to create	Huang & Lee, 2015; Lev-Zamir & Leikin, 2013
Promoting active learning	Huang & Lee, 2015; Lev-Zamir & Leikin, 2013; Turner, 2013
Tailoring content and methods to learners' needs	Alkhars, 2013; Huang & Lee, 2015; Lev-Zamir & Leikin, 2013
Encouraging collaboration among students and teachers	Alkhars, 2013; Huang & Lee, 2015
Empowering students to take ownership of their learning	Huang & Lee, 2015; Merriman, 2015
Offering students relevance	Henriksen & Mishra, 2015; Huang & Lee, 2015; Lev-Zamir & Leikin, 2013; Turner, 2013
Passing control over learning to students	Huang & Lee, 2015; Merriman, 2015
Building positive relationship with students	Alkhars, 2013; Hong & Kang, 2010

24 studies addressed teachers' beliefs about teaching for creativity. Strategies viewed by educators to promote creativity from qualitative studies could also be grouped around specific common themes, despite the varied contexts in which these were examined (see Table 5).

The two most frequent strategies found were those related to teaching divergent thinking and facilitating active learning, whereas less emphasized approaches included offering authentic experiences and feedback. Despite the several strategies cited by teachers also present in the literature (Lin, 2011), individual teacher groups across the studies had limited conceptualizations of creativity-fostering practices.

Quantitative surveys also highlighted that though teachers were aware of a number of strategies to promote students' creativity, several aspects of teaching for creativity were overlooked, while others were overemphasized.

Table 5. Teaching strategies viewed by teachers as connected to teaching for creativity in the literature in Study 1

Creativity-fostering strategies	Studies
Teaching divergent thinking	Alsahou, 2015; Lev-Zamir & Leikin, 2011; Levenson, 2013, 2015; Meyer & Lederman, 2013; K. A. Scott, 2015; Shen, 2014;
Facilitating active learning	Adams, 2013; Alsahou, 2015; Daskolia et al., 2012; Hondzel, 2013; Liu & Lin, 2014; Meyer & Lederman, 2013; Tanggaard, 2011
Encouraging students to make creative contributions and solve problems	Daskolia et al., 2012; Hondzel, 2013; Lev-Zamir & Leikin, 2011; Levenson, 2015
Empowering students to take ownership	Adams, 2013; Alsahou, 2015; Daskolia et al., 2012; Hondzel, 2013; Levenson, 2013
Passing control to learners	Adams, 2013; Daskolia et al., 2012; Liu & Lin, 2014; Shen, 2014
Promoting learner-considerate and inclusive environments	Daskolia et al., 2012; Hondzel, 2013; Levenson, 2013; Shen, 2014
Fostering collaboration	Alsahou, 2015; Daskolia et al., 2012; Hondzel, 2013; Levenson, 2013
Fostering positive relationships	Adams, 2013; Hondzel, 2013; Levenson, 2013; Shen, 2014
Offering authentic experiences	Daskolia et al., 2012; Hondzel, 2013
Offering feedback	Alsahou, 2015; Shen, 2014

Also, teachers often identified non-creativity fostering activities and conditions as creativity-fostering ones or vice versa. For example, more than half of the sample of primary US teachers in a study conducted by Aish (2014) supported open-ended assignments in promoting creativity, but also overemphasized the role of art, music and drama activities in teaching for creativity. A considerable number of US primary music teachers perceived collaboration, freedom to choose the mode of presentation and parameters with at least one given musical element as learning activities that promote creative thinking, but believed that the noisy environment had a negative effect on students' creative thinking (Fairfield, 2010). Greek primary PE teachers emphasized intrinsic motivation, autonomy, independence, whereas collaboration and divergent thinking were supported by only half of the participants (Konstantinidou et al., 2014). Stone (2015) found that art teachers stressed the use of questioning and encouraging risk-taking, but overlooked the importance of feedback. In Shaheen (2011), Pakistani primary

teachers supported all strategies in the questionnaire as creativity-fostering, even if many did not directly promote creativity. Two correlational studies investigating teachers' beliefs about the characteristics of the tasks that promote creativity conducted in the subject-area of mathematics found that teachers had difficulties in recognizing tasks that occasion mathematical creativity (Dickman, 2014; Newton & Newton, 2010).

Finally, studies focusing on the cross-cultural comparison of teachers' views regarding teaching for creativity highlighted several differences between how teachers in different countries view creativity-fostering activities (Hartley & Plucker, 2014; Hong & Kang, 2010). For example, Hong and Kang (2010) found that South Korean teachers emphasized divergent thinking and peer interactions whereas US teachers highlighted environmental and emotional support. Hong and Kang (2010) revealed that Chinese primary science teachers considered routine and fun activities to contribute more to student creativity, than did their American counterparts.

Perceptions about the enablers and barriers to fostering creativity in the classroom – Several barriers to fostering creativity, few enablers'

20 studies focused on the enablers of and barriers to fostering creativity as perceived by in-service K-12 teachers. 19 studies used open-ended questionnaire questions or qualitative data collection to explore educators' views on the topic. These studies revealed a range of factors which were considered by teachers as either barriers to and/or facilitators of fostering students' creativity in the classroom at the levels of the specific context, individual teachers, students and parents, as indicated by the following Table 6.

Barriers most frequently cited in the reviewed literature were lack of time, lack of training, overloaded curriculum, inadequate resources, standardized tests and difficulties in assessing creativity. At the level of teacher-related barriers, educators perceived more external than internal factors to hinder creativity. Furthermore, findings across the studies suggested that teachers perceived considerably fewer enablers to nurturing creativity in the classroom than barriers.

Most frequently reported perceived facilitators were the integration of ICT and the curriculum. It is noteworthy, that while certain factors, such as ICT or the curriculum, were considered barriers by certain samples, they were perceived as facilitators by others, suggesting that despite the several overarching themes, views on the facilitating and hindering factors of creativity are deeply rooted in the specific contexts of educators.

Table 6. Common perceived barriers and enablers to fostering creativity in the reviewed literature based on qualitative data in Study 1

Barriers	Studies
Context-level barriers	
Lack of time (11)	Aish, 2014; Al-Nouh et al., 2014; Alsahou, 2015; Cheng, 2010; Fairfield, 2010; Frawley, 2014; Hondzel, 2013; Hong & Kang, 2010; Kampylis, Saariluoma, & Berki, 2011; K. A. Scott, 2015; Shaheen, 2011; Zhou et al. (2013)
Overloaded curriculum (9)	Aish, 2014; Al-Nouh et al., 2014; Alsahou, 2015; Cachia & Ferrari, 2010; Cheng, 2010; Fairfield, 2010; Kampylis et al., 2011; K. A. Scott, 2015; Shaheen, 2011
Exams, standardized tests (8)	Aish, 2014; Al-Nouh et al., 2014; Fairfield, 2010; Hondzel, 2013; Hong & Kang, 2010; Olivant, 2015; K. A. Scott, 2015; Shaheen, 2011
Inadequate materials, resources, facilities (8)	Al-Nouh et al., 2014; Alsahou, 2015; Cheng, 2010; Fairfield, 2010; Hondzel, 2013; Kampylis et al., 2011; K. A. Scott, 2015; Shaheen, 2011
ICT (2)	Hondzel, 2013; Scott, 2015
Large class sizes (3)	Hong & Kang, 2010; Kampylis et al., 2011; Shaheen, 2011
Unsupportive school culture (6)	Alsahou, 2015; Cachia & Ferrari, 2010; Cheng, 2010; Fairfield, 2010; Kampylis et al., 2011; K. A. Scott, 2015
Unsupportive social culture (3)	Hong & Kang, 2010; Kampylis et al., 2011; Shaheen, 2011
Teacher-level barriers	
External	
Lack of training (9)	Aish, 2014; Al-Nouh et al., 2014; Alsahou, 2015; Cachia & Ferrari, 2010; Cheng, 2010; Fairfield, 2010; Kampylis et al., 2011; Shaheen, 2011; Snell, 2013
Heavy workload (4)	Alsahou, 2015; Cheng, 2010; Kampylis et al., 2011; Shaheen, 2011
Lack of freedom and autonomy (2)	Alsahou, 2015; Hong & Kang, 2010
Challenges of assessing creativity (8)	Alsahou, 2015; Cheng, 2010; Hong & Kang, 2010; Kampylis et al., 2011; Konstantinidou et al., 2014; K. A. Scott, 2015; Shaheen, 2011; Tomasevic & Trivic, 2014
Internal	
Challenges of teaching creativity skills (5)	Cheng, 2010; Fairfield, 2010; Hong & Kang, 2010; Shaheen, 2011; Snell, 2013
Traditional teaching methods (5)	Al-Nouh et al., 2014; Cheng, 2010; Fairfield, 2010; K. A. Scott, 2015; Shaheen, 2011
Lack of knowledge about creativity (2)	Alsahou, 2015; Hong & Kang, 2010
Student-level barriers	
Individual differences between students (3)	Cheng, 2010; Frawley, 2014; Shaheen, 2011
Lack of engagement (3)	Cheng, 2010; Shaheen, 2011; Snell, 2013
Parent-level barriers	
Negative attitude and lack of support (4)	Alsahou, 2015; Cheng, 2010; Fairfield, 2010; Shaheen, 2011
Enablers	
Context-level enablers	
Curriculum (4)	Adams, 2013; K. A. Scott, 2015; Shen, 2014; Tomasevic & Trivic, 2014
ICT (6)	Adams, 2013; Alsahou, 2015; Cachia & Ferrari, 2010; Hondzel, 2013; 2015; Shen, 2014; Tomasevic & Trivic, 2014
School culture	Adams, 2013; Hondzel, 2013
Teacher-level enablers	
Teachers' attitudes, knowledge, skills (2)	Merriman, 2015; K. A. Scott, 2015
Student-level enablers	
Students attitudes, knowledge and skills (2)	Adams, 2013; Alsahou, 2015
Parent-level enablers	
Parental attitude and support (2)	Adams, 2013; Hondzel, 2013

Cross-cultural similarities and differences in educators' perceptions of the barriers of fostering were also directly investigated in two studies. Zhou et al. (2013) found that German teachers considered work pressure, resources and discipline as most important creativity-hindering factors, whereas for Japanese teachers it was the evaluation systems both for students and teachers. Also, Hong and Kang (2010) found that in addition to overloaded curriculum, class size and the assessment of creativity, which were viewed by both American and South Korean teachers as barriers to promoting creativity South Korean teachers also mentioned the lack of teachers' own experience with and knowledge about creativity and pressure for student achievement, suggesting further cross-cultural differences.

4.3.2 What is known about teachers' beliefs with regard to nurturing creativity in with technology*?*

Of the 53 studies focusing on teachers' pedagogical beliefs about creativity in the recent literature only seven reported findings regarding the use of technology to promote students' creativity in K-12 education with none focusing explicitly on the topic. Research applying quantitative, qualitative, and mixed methodologies revealed teachers' different stances when it comes to using technology to promote creativity in the classroom. Thus, teachers across studies viewed technology both as an enabler and barrier to creativity in the classroom as indicated in the previous Section 4.3.1. In addition, in-depth inquiries of teachers' beliefs and practices also highlighted some technology-enabled activities that teachers believed to foster creativity.

Technology viewed as an enabler to creativity in the classroom

Two of the seven studies reported that most participants expressed the view that digital tools could enable creativity in the classroom, the cross validation of findings, however, suggested that teachers in the studies rarely applied them (Alsahou, 2015; Cachia & Ferrari, 2010). In a large-scale survey study investigating European teachers' perceptions about creativity Cachia & Ferrari (2010) revealed that a vast majority (91%) of participants claimed that technology could be used to enhance students' creativity across the different grade levels and curricular areas of curriculum. At the same time, teachers' subsequent answers showed that only half (53%) left their students use a wide

range of technologies to learn (e.g. videos, mobiles, cameras, educational software), while others preferred mainly teacher-centered approaches.

In an in-depth inquiry of Kuwaiti teachers' pedagogical beliefs and practices of fostering creativity in the science curriculum, Alsahou (2015) found that all participants discussed the effectiveness of integrating technology to foster students' creativity. Specifically, participants perceived applying technology as an important factor to achieving three aims with respect to creativity: (1) enhancing students' personal development through unlimited access to mobile technology which could facilitate the conduct of inquiries in the classroom, (2) capturing students' attention and sparking their interest through the use of social networking applications, online games, and websites, which were considered attractive for teenagers, and (3) by enhancing the quality of lesson delivery, especially through simulation and visualisation tools. Though technology integration was one of the most agreed-upon factors among all the teachers in the study, observation data revealed that digital tools during the lessons were implemented with a teacher-centred approach focusing only on the direct transmission of knowledge, specifically through presentations.

Technology viewed both as enabler and barrier to creativity in the classroom

Teachers in one study discussed both the positive and negative effects they believed technology might have on students' creativity (Adams, 2013). Examining the integration of critical and creative thinking skills in the elementary curriculum in the United States, Adams (2103) reported that several participants mentioned the use of technology as an important strategy to foster elementary school students' creativity. The technologies teachers found most valuable in promoting creativity included Smart Board for games or interactive learning, the use of the Internet for research, games, or video clips, use of iPads, and voice threads. In addition to the perceived positive effects, teachers in the study also commented on the negative aspects of technology for creative thinking arguing that students refused to think on their own when technology was available for them.

Technology viewed as a serious barrier to students' creativity

One study highlighted that technology could be considered as a serious barrier to creativity by teachers. In a phenomenological investigation aimed at describing how US

exemplary teachers conceived creativity and their duty to foster it, Scott (2014) reported that technology emerged as a substantial barrier to creative thinking for several participants. These participants, though did not deny that technology could lead to great innovations and creativity in the world, indicated that digital tools were detrimental for students' creativity, especially due to the constant disruptions they caused. Some participants also commented that learning with technology was often superficial. One participant teacher, for example, argued that technology "dulls the imagination", also explaining that since the mobile phone ban was lifted in the school, her students showcased less in-depth thinking in the classroom (Scott, 2013, pp. 211-212).

Lack of emphasis on the role of technology to promote creativity

Finally, a lack of emphasis with which teachers indicated the role of technology was evident in three studies (Hondzel, 2013; Shen, 2014; Tomasevic & Triptic, 2014). Hondzel (2013) investigated Canadian teachers' creativity fostering beliefs and behaviours, and found that though most teachers in the study reported that they used modern technology in the classroom, (Smart Board, IPads, laptops, computers), these were more seen in terms of usefulness rather than as tools for students to demonstrate or enhance their personal creativity, or for teachers to foster students' novel or original ideas. Shen (2014) exploring US elementary teachers' interpretations and practices of nurturing creativity in mathematics, and Tomasevic and Trivic (2014) focusing on Serbian chemistry teachers' creativity-beliefs indicated that participating K-12 teachers shared the view that technology was part of the creativity stimulating learning environment, further views were nevertheless not expressed or explored.

4.3.3 What is known about the relationship between teachers' beliefs about creativity and classroom practices?

Despite the large number of studies focusing on teachers' creativity-related views found in the current empirical literature, exploring the relationships between teachers' beliefs about creativity and instructional practices has been the focus of a relatively small number of studies (n=19). Some of these investigated the direct relationship between teachers' espoused beliefs and enacted practice triangulating the data collected from questionnaires, interviews, documents with those obtained through classroom

observation. Another group of studies revealed associations between teachers' beliefs and practices regarding creativity indirectly either by comparing teachers' perspectives with those of other participants', such as students or professional colleagues or by relying exclusively on teachers' self-reports.

The relationship between teachers' espoused beliefs and enacted classroom practices

Seven studies included in the present review compared the direct relationship between teachers' espoused beliefs about creativity and their enacted classroom practices. Adams (2013) showed that teachers' definitions of and experiences with creativity had an impact on teaching creativity skills. In her multi-case study conducted in a school district from Pennsylvania, primary teachers provided examples of classroom practices which were in alignment with how these teachers defined creativity: those who viewed creativity as thinking outside the box offered lesson examples in which students were asked to generate unique solutions, whereas those who argued that creativity involved the application of knowledge required students to create or build a product. The same consistency between views and practices was found by Lasky and Yoon (2011) in their grounded theory study set in the US which investigated teachers' assumptions about creativity in the context of an engineering design project. Lasky and Yoon (2011) showed that teachers' views, both those aligned with creativity research and those based on misconceptions, were evident in teachers' classroom practices, contributing to either the encouragement of creativity or its suppression.

Other studies highlighted inconsistencies between teachers' beliefs, perceptions and practices concerning creativity. For example, in his multiple study involving primary school science teachers and students from Kuwait, Alsahou (2015) found some positive creativity-fostering beliefs, but a lack of creativity-fostering practices, across the eight cases he examined. The study also indicated incongruence between technology-enabled creativity beliefs which reflected student-centred approaches and teachers' actual practices which primarily involved teacher-centred activities of knowledge transmission. Similarly, Lev-Zamir and Leikin (2013), in their phenomenological study examining two mathematics teachers' creativity beliefs in Israel, noted that that although the teachers' declarative conceptions of creativity in mathematics were similar, their conceptions-in-action showed significant differences. In his grounded theory study focusing on English

language teachers' understanding of creativity in the context of primary education in Kuwait, Alkhars (2013) found several similarities and differences between how participants viewed creativity in the interviews, and how they acted it in the classroom.

Additional studies highlighted a mismatch between positive self-reported views and classroom practice regarding the encouragement of creativity. In a mixed method study focusing on teachers' creativity beliefs in science, Meyer and Lederman (2013) pointed out that secondary science teachers valued creativity and claimed to encourage it in the classroom, but they demonstrated misconceptions about the nature and efficacy of certain activities in promoting scientific creativity in their practice. Further misalignment between teachers' positive creativity views and classroom practices were revealed by Shaheen (2011) in an explanatory mixed method study conducted in Pakistani primary education settings. Primary teachers in the study outlined several methods for encouraging students' creativity in their survey responses. Observational findings showed, however, that these methods were completely absent from the classroom instruction during which teachers emphasized rote memorization rather than creativity. Furthermore, many teachers claimed that textbooks promote creativity, nevertheless the analysis of these concluded that the contents of these focused primarily on knowledge acquisition.

Differences in teachers' and non-teachers' self-reported beliefs

Three studies focused on comparing in-service teachers' self-reported creativity views with the perspectives of other participants, such as students, principals and domain professionals. Investigating teachers' and students' perceptions of the creative climate in the English secondary design and technology classroom in the UK, McLellan and Nicholl (2012) revealed several differences. While students felt that their task lacked challenge, were often asked to do meaningless work, had limited freedom, and needed more support to realize their ideas, many teachers felt quite the opposite. For example, few teachers acknowledged that the work they set was unchallenging and some did not see the necessity of setting real-life meaningful tasks. Also, few recognized the contradiction between indicating that they granted students freedom and affirming to control learning outcomes or simply not allowing students enough time for exploration and risk-taking. Misalignment between teachers' and students' views were also highlighted by Hartley (2015), who, in her study sampling elementary science teachers and their students in

China, found a statistically significant difference between teachers' perception of how they encouraged primary students' mini-c creativity and their students' creative self-efficacy beliefs in science. According to Hartley (2015), teachers' positive perceptions of creativity-fostering practices and lower student self-efficacy scores suggested that educators might have overestimated the extent to which they promoted creativity in the classroom. Investigating how primary mathematics teachers, mathematicians, and psychologists working in mathematics education conceive creativity, Dickman (2014) found that there was no intra-group agreement among teachers with regard to what constitutes a creative multiplication problem, whereas intragroup agreement was found among psychologists who worked in mathematics education, and poor agreement in case of mathematicians.

Inconsistencies in teachers' self-reported creativity beliefs

There were nine studies that uncovered the associations between teachers' beliefs and practices regarding creativity based on teachers self-reports. These studies all revealed inconsistencies or inadequacies in teachers' self-reported beliefs about the encouragement of creativity. For example, in a case study examining Kuwaiti EFL teachers attitudes and perceptions of practice regarding creative thinking, Al-Nouh et al. (2014), found that while most teachers had positive attitudes towards creativity and strong perceptions of encouraging it, some of them perceived non-creativity-fostering EFL activities as creative ones. Examining primary teachers' conceptions of scientific creativity Newton and Newton (2010) found that some teachers did not have clear conceptions of what scientifically creative thought was, and could not distinguish between creative and reproductive activities. Furthermore, in a survey study conducted by Zbainos and Anastasopoulou (2012), Greek music teachers expressed high levels of self-efficacy in teaching and assessing creativity-fostering music activities, nevertheless many of them perceived non-creative activities as creative, also having vague ideas about how to assess students' creativity in music.

Four survey studies (Aish, 2014; Cachia & Ferrari, 2010; Fairfield, 2010; Konstantinidou et al., 2014) reported that though teachers held positive views about creativity and had high perceptions of fostering it, they did not support a number of classroom activities that could encourage students' creative expression, including those enhanced by technology (Cachia & Ferrari, 2010). A correlational study aimed at

investigating US teachers' implicit conceptions of creativity showed that though teachers held positive beliefs about creativity and felt capable of nurturing students' creative potential, they perceived low levels of environmental encouragement, suggesting that they might not feel able to foster creativity in their current environment (DaVia Rubenstein et al., 2013).

Finally, in two survey studies many teachers claimed to foster student' creativity, but did not provide examples of activities when prompted to do so (Al-Nouh et al., 2014; Tomasevic & Trivic, 2014), which might indicate a lack of time or interest towards completing the survey. It may, however, also signal a lack of knowledge about strategies that encourage creativity in education.

4.3.4 Section summary

This section presented the results of the systematic literature review conducted in Study 1 to investigate teachers' beliefs about creativity and its' nurture, including those involving the use of technology, in the recent empirical base. The next section discusses the finding presented in relation to the existing body of knowledge on creativity and its nurture both with and without the use of technology.

4.4 DISCUSSION

The purpose of this section is to discuss the major findings of the systematic literature review on teachers' beliefs about creativity in relation to the existing body of knowledge within the area of focus of the current study. First the limitations of the research reviewed will be discussed (Section 4.4.1), which is followed by the discussion of the findings on teachers' beliefs about creativity (Section 4.4.2). Next, findings on teachers' beliefs about the role of technology in fostering students' creativity is discussed (Section 4.4.3). The fourth sub-section focuses on the discussion of relationships between teachers' espoused beliefs and enacted creativity-fostering practices (Section 4.4.4). The final section aims to summarize the discussion and link it to the conclusion section which also discusses the implications of Study 1 for Study 2 (Section 4.4.5).

4.4.1 Limitations of the research reviewed

Study 1 reviewed K-12 in-service teachers' beliefs about creativity in the recent empirical research. A systematic literature review was conducted yielding 53 studies that met the inclusion criteria. Overall, the recent evidence base on teachers' beliefs about creativity and its nurture is considerable, the topic having attracted growing attention worldwide. Yet studies are of variable quality with some apparent weaknesses, notably uneven and limited investigation contexts, unstated or less adequate theoretical framing, less appropriate research design, and restricted data collection.

As a whole, the database reviewed is uneven and limited from several contextual perspectives. Though research was conducted worldwide, a significant number of studies, namely 15, address the US context. Five studies are from China and Greece, four from the UK and Israel, with more authored or co-authored by the same researchers or even involving the same samples. It is noteworthy though that, while scarcer, studies also emanate from a further ten countries, signalling an increasing global interest. Also, there is a preponderance of studies conducted in primary school settings. The evidence base on secondary teachers' views is more limited, which might convey to stakeholders the message that creativity has no relevance for higher levels. Further imbalance in the reviewed literature was found with respect to the study of educators' domain-specific views. More than half of the studies explore teachers' domain-specific beliefs about creativity in a wide range of subject areas, while the rest focus on domain-general contexts. Surprisingly, domain-specific beliefs are extensively explored in mathematics and science, with considerably fewer studies in other areas. Furthermore, many studies recruiting teachers from different phases of education and subject specializations disregard the comparison of views based on these variables, while others omit to specify grade levels and the subjects taught by the participants, treating primary, middle and secondary educators of different subjects as a homogenous group. Also, teachers included in the samples vary along several individual variables, the exploration of views based on these is, nevertheless, rare. Finally, the reviewed studies mainly focus on cross-cultural comparisons, yet it has been shown that several further external factors, such as national and district policies, curriculum and teaching materials, school culture, reaction from parents and students can shape teachers' beliefs (Fives & Buehl, 2012; Pajares, 1992; Richardson, 1996). Recent literature thus seems to emphasize teachers' general beliefs

about creativity, and provides less evidence on those specific beliefs activated by various individual factors and the contexts in which teaching and learning take place.

As for the theoretical framing, much of the research conducted after 2010 is based on current theories of creativity. Still, there are a number of studies offering vague or outdated conceptualizations, and thus their findings are difficult to relate to the rest of the literature. Furthermore, the inconsistency of the use of belief terms and the lack of operational definitions renders the interpretation of research findings more difficult.

In terms of methodological quality, the divergence of approaches, methods, instruments and sample sizes posed serious challenges to synthesizing results. Included studies are either larger-scale quantitative surveys or smaller qualitative and mixed studies, both having distinctive strengths and drawbacks in the context of studying teachers' beliefs about creativity. Larger-scale quantitative studies may yield more generalizable results, however, none of the samples in the reviewed research is truly representative. Small-scale qualitative and mixed studies offer more in-depth data about teachers' beliefs concerning creativity, however, it is not known how these relate more widely, especially with studies focusing on very few teachers (eg. Lev-Zamir & Leikin, 2013; Levenson, 2015). Another limitation identified is that most studies are cross-sectional with only a few applying longitudinal designs (Adams, 2013; Levenson, 2015; Levenson & Gal, 2013), thus recent research fails to provide sufficient evidence on educators' changing perspectives.

As for the methods used, researchers rely primarily on self-reported measures as proxy for teachers' enacted behaviours, with only a handful of studies investigating the direct link between teachers' espoused beliefs and classroom practices. Inferences made on grounds of self-reports only is nevertheless highly questionable (Pajares, 1992).

Despite these limitations, the included studies provide a sufficient body of evidence to answer the questions posed by this review and to highlight implications for future research and practice.

4.4.2 Teachers' beliefs about creativity in the recent literature

The first question of Study 1 concerned the evidence-base on teachers' beliefs about creativity in the light of recent empirical literature. The review found that researchers investigated educators' creativity-related views along three strands or foci: teachers'

beliefs about the nature of creativity, creative individuals, and creativity-fostering classroom environments. Teachers beliefs about creative teachers and teaching creatively were two emergent themes in the literature after 2010. An updated conceptual framework of teachers' beliefs about creativity based on the recent empirical research is presented by the following *Figure 10*.

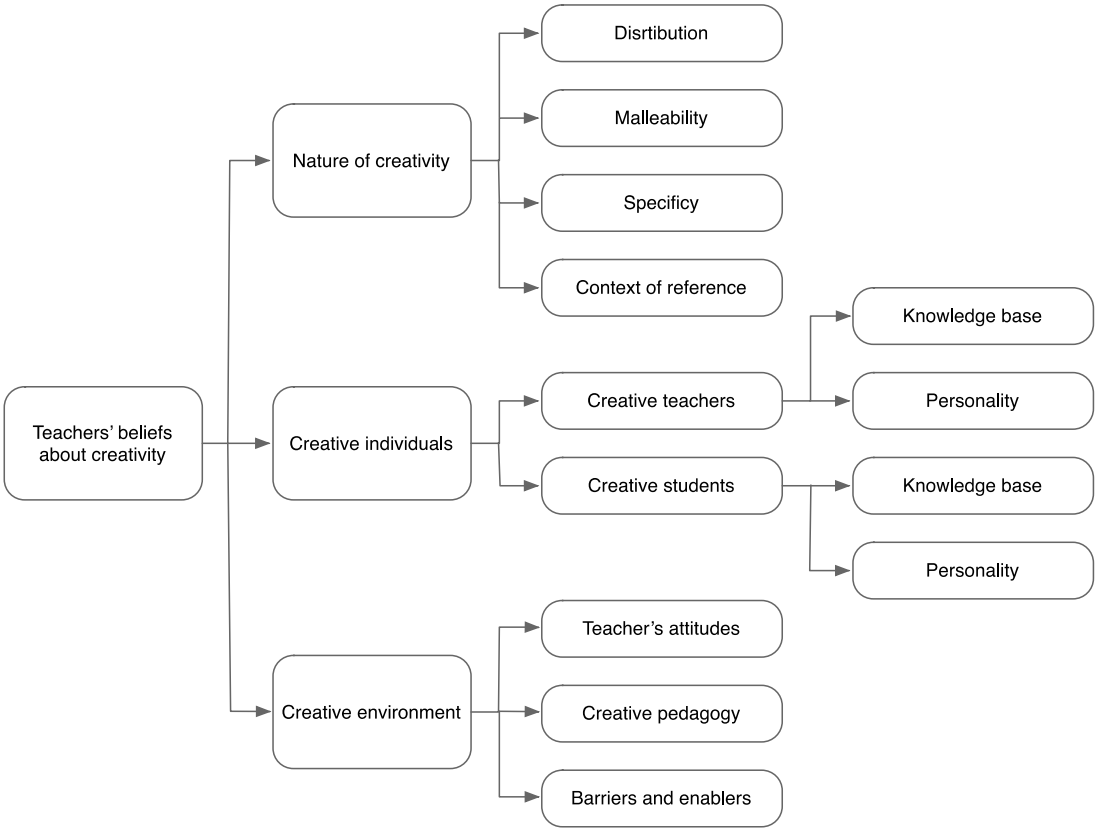


Figure 10. Teachers' beliefs about creativity: An updated conceptual framework based on the systematic review in Study 1

With respect to the nature of creativity, recent evidence-base suggests that in line with current creativity research, teachers generally endorse a democratic view of creativity and support the idea that creativity can be nurtured. Nevertheless, findings also highlight that teachers in particular settings hold opposing beliefs (Myhill & Wilson, 2013; Pavlović et al., 2013; Zbainos & Anastasopoulou, 2012) which may arise from several contextual factors, for example the deficit of creativity training in initial teacher education and the lack of available professional development courses and resources (Pavlović et al., 2013; Zbainos & Anastasopoulou, 2012), or the difficulties of conceptualizing creativity in highly specific areas, such as student poetry writing (Myhill & Wilson, 2013). Also, teachers across recent studies generally agree that creativity can manifest in any domain, however, some of them are slightly biased towards art-related

subjects in Western cultural contexts (Cachia & Ferrari, 2010) and towards science in Eastern settings (Zhou et al., 2013). It is also important to note that teachers widely acknowledge the role of creativity in their own subjects as highlighted by several subject-specific investigations. Overall, a growing recognition of creativity inherent in every subject is evident in recent studies as compared to the literature before 2010 synthetized Andiliou and Murphy (2010), which might further the implementation of creativity across all areas of the curriculum.

Unfortunately, reviewed studies on educators' beliefs about the nature of creativity highlight that, regardless of the cultural context, originality and value as joint requirements for creativity are rarely recognized by teachers, who continue to mostly emphasize the originality aspect of creativity, a trend also highlighted in studies conducted before 2010 (Andiliou & Murphy, 2010). Seeing creativity as a form of originality minimizes the importance of skills and knowledge in the creative production, leading to an environment in which creativity competes with academic learning instead of supporting it (Beghetto et al., 2014). It is noteworthy, though, that the idea that creativity requires both originality and value is supported by highly-accomplished expert teachers (Henriksen & Mishra, 2015; Scott, 2015), who thus might play an important role in promoting research grounded beliefs among educational stakeholders.

Findings with respect to creative students show that researchers' and teachers' conceptualization of the profile of creative student differ in many aspects, and teachers often have limited, vague and mixed ideas of what characterizes creative students, with several variations across the investigation contexts. Also, teachers in recent studies still tend to identify favourable characteristics as creative (Andiliou & Murphy, 2010), though it has been shown that characteristics of creative persons are not always socially desirable (Davis, 2004). Furthermore, teachers continue to have difficulties in recognizing creative students in the classroom and are often positively biased towards students with high intellectual abilities and school achievement, and good behavior as also shown in the literature before 2010 (Andiliou & Murphy, 2010). Thus, it is most likely that student creativity still goes unrecognized in many classrooms around the world.

Creative teachers in the studies reviewed are described by educators in terms of personal characteristics, pedagogical and subject-specific knowledge and skills, again with several contextual and cross-cultural variations. Teachers across several studies

support the idea that fostering creativity requires creative teachers, a view also emphasized in the literature (Jeffrey & Craft, 2004).

Recent research on teachers' beliefs concerning classroom environments conducive to creativity shows that teachers generally have positive attitudes towards creativity, many believe that they are capable of fostering creativity and perceive themselves as doing so. Nevertheless, cross-validation of data collected from other participants and classroom observation, if carried out, often highlights incongruence between educators' espoused beliefs and enacted classroom practices, suggesting the implementation of creativity in the classroom is questionable. In line with creativity research, creative teaching is often seen as inherently linked to promoting creativity in the classroom and a skill that can be learnt by any teacher (Lin, 2011). Also, though teachers are aware of several strategies that promote students' creativity, many aspects of teaching for creativity are overlooked while others overemphasized. Finally, teachers perceive several barriers, and far fewer enablers, to fostering creativity in the classroom. Lack of time, overloaded curriculum, lack of training, standardized tests and difficulties in assessing creativity are the most widely cited barriers in recent empirical literature, which are also often seen as hindering factors in creativity education (Skiba et al., 2017; Sternberg, 2015).

4.4.3 Teachers' beliefs about the role of technology in fostering creativity

In relation to the second research question, the review found that teachers across the studies adopted various stances with regard to the role of technology in promoting students' creativity, viewing technological tools and devices either as important enablers, as serious barriers, or as both enablers and barriers to creativity in the classroom.

Several researchers argued that technology could make distinctive contributions to the promotion of creativity in the classroom by allowing students to develop and explore ideas in new ways, create a wide variety of digital products, collaborate in diverse teams, and communicate their creative work with a wide range of audiences (Glăveanu et al., 2019; Loveless 2003; 2007; Lubart, 2005; Nikolopoulu, 2015; Mishra et al., 2013). In addition, the literature on creativity and technology also provided some evidence that creativity can be fostered through digital tools (Scott, 2004a, 2004b; Ma, 2006). In line with theory and research, teachers across five studies also expressed the view that students' creativity could be fostered through technology-based activities in the

classroom (Adams, 2013; Alsahou, 2015; Cachia & Ferrari, 2010; Shen, 2014; Tomasevic and Triptic, 2014). Unfortunately, only a few studies in the literature reviewed in Study 1 explored teachers' beliefs about the ways in which technology could promote creativity. In these studies, digital tools were argued to stimulate students' creative capacities by allowing them instant access to information during inquiries through the Internet (Adams, 2013; Alsahou, 2015), raising students' curiosity and interest through digital games or other interesting online resources (Adams, 2013; Alsahou, 2015), and by increasing the quality of teaching (Alsahou, 2015). The use of the Internet during student-led inquiries as well as online interactive resources that enable student to develop and explore ideas are suggested to support creativity in the classroom by researchers, too (e.g. Loveless, 2002, 2007; Nikolopoulu, 2015), whereas the assumed effects of technology on students' creativity through quality teaching aligns with the idea that creative teaching might lead to creative learning in the classroom (Lin, 2011). On the other hand, several uses of technology for learning, such as trying out ideas, creating purposeful outcomes across the curriculum, or collaborating with others during the creative process were not addressed by teachers in the studies reviewed.

Researchers have pointed out that the various technologies represent a set of tools that can be chosen as and when appropriate in the creative process (Loveless, 2002; 2007), also emphasising that technology may also hinder creativity (Glăveanu et al., 2019). Some teachers across the studies reviewed expressed a similar view (Adams, 2013; Scott, 2015). Negative aspects of technology-use with regard to creativity mentioned in these studies included the disruptions caused by technology (Scott, 2015) as well as the detrimental effects of the quick and easy access to information on students' creative thinking (Adams, 2013; Scott, 2015). It is interesting to note, that the view that technology supresses creativity for students was strongly upheld by a group of exemplary teachers (Scott, 2015). Though several studies examined how technology can be used to create conditions that stimulate creativity (e.g. Guegan et al., 2016; Guegan, 2017; Ritter et al., 2012), research on the negative effects of technology on student creativity in K-12 settings is dearth.

Finally, there were only two studies in the reviewed literature which in addition to exploring teachers' pedagogical beliefs about creativity and technology also examined the enactment of such beliefs (Alsahou, 2015; Cachia & Ferrari, 2010). These studies indicated that though valuing technology in promoting creativity, teachers did not

translate (Alsahou, 2015) or many teachers most likely did not translate positive beliefs into creativity-fostering classroom practices. The incongruence between beliefs and practice is not uncommon finding in the literature (Fives & Buehl, 2012), and will be discussed in relation to the results of this review in the next section.

4.4.4 The relationship between teachers' creativity beliefs and practices

The significance of teachers' beliefs lies in their relationship to enacted classroom practices and ultimately student outcomes (Fives & Buehl, 2012), which was the focus of our second research question in Study 1. While most studies in the reviewed literature suggest some link to instructional practice and student outcomes, only a few investigate this connection using data both from teachers and students, while the majority rely exclusively on data reported by teachers.

On the whole, research shows incongruence or varying degrees of congruence between teacher' espoused beliefs and enacted practices. The few studies using classroom observation to strengthen the validity of teachers' self-reports suggest that negative beliefs or those misaligned with current creativity research are often reflected in teachers' practices, while positive and adequate beliefs rarely translate to creativity-fostering classroom practices. Studies comparing data collected from teachers and other participants report misalignment between teachers' positive perceptions of fostering creativity, and other participants' perceptions of these educators' practice. Finally, evidence based on teachers' self-reports shows that positive perceptions of fostering creativity are often paired with insufficient knowledge about the ways in which creativity can be nurtured, making the implementation of creativity in the classroom unlikely.

The incongruence between teachers' beliefs and practices may have various reasons, as outlined by Fives and Buehl (2012). First, while teachers may hold a certain belief, other beliefs may influence their actual practices. Unfortunately, included studies focus on teachers' views on creativity without examining potentially associated beliefs, such as learning, intelligence or knowledge etc. Second, the enactment of certain beliefs can be hindered by various internal and external factors. It is possible, thus, that teachers' positive beliefs about creativity are outweighed by the demands and constraints of the context in which they manifest, also suggested in the literature (Sternberg, 2015). Third, the incongruence between beliefs and practice is more frequent with newly formed beliefs

or those in transition. The interest in creativity in mainstream education is relatively recent (Beghetto, 2010), therefore it is possible that teachers' conceptualizations of creativity are still in the process of forming. Fourth, the methodology applied may also contribute to the findings, for example in detailed analysis inconsistencies in beliefs may occur due to the wealth of data, whereas quantitative investigations may obfuscate the complexity of the relationship between beliefs and practice (Fives & Buehl, 2012). These limitations are rarely addressed in the research reviewed. Finally, teachers may simply express beliefs they do not hold. This could be especially true for creativity, since it is socially desirable for teachers to claim they value creativity in the classroom, even if they do not (Fives & Buehl, 2012; Runco & Johnson, 2002; Shaheen, 2011).

4.4.5 Section summary

This section discussed the major findings of the systematic literature review on teachers' beliefs about creativity in relation to the existing body of knowledge within the area of focus of the current study. The next section (Section 4.5) will present the conclusions drawn from Study 1 as well as the its implications for Study 2 of the qualitatively-driven multimethod research.

4.5 CONCLUSIONS

The purpose of Study 1 was to describe, appraise and synthesize the most rigorously available current empirical research base on in-service K-12 teachers' beliefs about creativity and its nurture with special focus to the perceived roles of technology in fostering creativity. Study 1 applied a systematic literature approach to answer the research questions and drew data from a systematically identified empirical evidence base consisting of 53 studies published between 2010-2015 on teachers' beliefs about creativity and its nurture.

The review highlighted a growing research interest in teachers' creativity beliefs in recent years, with a large number of studies published as journal articles and dissertations around the globe. Studies included in the review investigated teachers' creativity beliefs along three main themes: teachers' beliefs about the nature of creativity, creative

individuals and classroom environment conducive to creativity. Teachers' beliefs about nurturing creativity with technology was addressed only in a limited number of studies.

Overall, the following conclusions can be made on the basis of the review. First, teachers hold several beliefs which could act as enablers to promoting creativity in the classroom, such as they generally value creativity, many believe that it can be nurtured in every student and across many subjects, and are aware of a number pedagogical strategies to promote it. Specific areas in which educators require more support include: the recognition of originality and appropriateness as joint requirements for creative outcomes; the conceptualization of creativity in different subject areas; the identification and appreciation of creativity in students; and the development of more awareness about the characteristics of pedagogical practices conducive to creativity across the curriculum and various education levels. In addition, teachers perceive few enablers and several barriers to nurturing creativity in the classroom. Most notable barriers are lack of time and training, inadequate resources, overloaded curriculum, standardized tests and difficulties in assessing creativity, which can easily outweigh teachers' positive beliefs and prevent the implementation of creativity in schools. The synthesis of the recent literature also highlighted that though common trends can be identified, teachers' views may vary considerably across teacher samples suggesting that beliefs about creativity are deeply rooted in the specific contexts of the educators. It has been also found that highly-accomplished expert teachers' views were in-line with current research.

Second, the review highlighted that teachers may adopt various stances with regard to the role of technology in promoting creativity, which was viewed as an enabler or as a barrier, or both as an enabler and barrier of students' creative development by teachers across the studies. Few studies explored teachers' beliefs in-depth. In these studies, technology was argued to support idea development as well as to increase students' curiosity and interest necessary for creativity in the classroom. Negative effects of technology on creativity reported by teachers included disruption and the suppression of thinking by access to ready-made answers. Such claims need empirical testing in K-12 settings.

Finally, the review revealed various degrees of congruence and recurrent incongruence between teachers' espoused beliefs and enacted practices. It was found that even if teachers' hold positive or adequate beliefs about creativity and its nurture with or without technology, these rarely translate into creativity-fostering practices, suggesting

that there are a number of internal and external factors that might prevent educators from nurturing creativity in the classroom.

4.5.1 Limitations

The review is subject to the usual limitations and threats to the validity of systematic reviews. Despite the pilot searches, hand searching of important journals, forward referencing of past seminal studies and reference list checking of included studies for other relevant work, some research may have not been identified. Also, as I searched for English-language resources only, an English-language bias is inevitable. The findings of the review are also inherently limited by the quality of available evidence. By designing and implementing a quality assessment protocol, low-quality studies were excluded to not adversely affect the review outcomes. For reasons of heterogeneity of the research on teachers' creativity beliefs, a narrative synthesis has been conducted, which is by nature a more subjective process. The interpretation of the literature, for example, may be coloured by the researchers' views. Also, to ensure accuracy and reliability, data collected were checked, themes and interpretations were agreed on with my advisor and when needed other experts were involved.

4.6 IMPLICATIONS FOR STUDY 2

The goal of the current dissertation was to explore teachers' beliefs about and experiences with nurturing student creativity in technology-integrated learning environments with the aim of generating themes and questions for future research on creativity, learning, and technology grounded in the realities of the classroom as well as to support policy, teacher education, and practice in the area of technology-enhanced creativity education. The dissertation adopted a qualitatively-driven sequential multimethod approach to research. First, a systematic literature review was conducted to determine the nature of teacher' beliefs and experiences with nurturing creativity in both offline and technology-integrated learning environments in the recent empirical research base (Study 1), then multiple case studies (Study 2) were carried out to resolve the issues uncovered by the systematic review and provide a logical extension to it. Main implications of systematic literature review (Study 1) for the subsequent multiple case study (Study 2) were the following:

- Study 1 showed that the contexts in which teachers' beliefs about creativity and its nurture have been investigated are uneven and limited. More research exploring teachers' beliefs in secondary education, various knowledge domains, and cultural settings are needed. Therefore, Study 2 was conducted in secondary school settings with respect to six curricular areas (EFL, Hungarian language and literature, mathematics, science, social studies, and visual arts).
- Study 1 showed that research on teachers' beliefs about fostering creativity with technology is dearth. Especially in-depth investigations which could inform future research on creativity, technology, and learning in K-12 settings grounded in the realities of classroom were notably missing from the literature. Therefore, Study 2 adopted a case study approach which allowed an in-depth exploration of teachers' beliefs about nurturing creativity with technology, while as participants it involved educators highly accomplished in the field of digital pedagogy.
- Study 1 highlighted that a more comprehensive examination of teachers' beliefs as a system is necessary. Therefore, Study 2 was designed to explore teachers' beliefs about nurturing creativity in relation to their perspectives about the nature of creativity, and creativity-fostering classroom environment.
- Study 1 showed that there is a need for more research that explores teachers' perspectives together with those internal and external factors that enable or hinder the enactment of creativity beliefs. Such studies would offer a better understanding of how the elements of teachers' belief systems interact and influence their creativity-fostering practice. Therefore, Study 2 was designed to explore the barriers and enablers that teachers perceive to fostering creativity with technology in the classroom.
- Finally, Study 1 revealed several methodological issues in the empirical research base. Researchers need to triangulate data collected from self-reported measures to improve the validity of their findings. More mixed method and qualitative studies are required to explore teachers' in-depth beliefs in relation to their classroom practices. Therefore, Study 2 was designed to collect and triangulate data from various sources: semi-structured interviews, classroom observation, document and image analysis.

The next Chapter 5 will present the multiple case study research (Study 2) conducted to explore Hungarian digital pedagogy expert secondary school teachers' beliefs and practices of nurturing creativity with technology to extend on the findings of the systematic literature review (Study 2) and identify further research themes on the relationships between creativity, technology, and learning grounded in the realities of the classroom.

Chapter 5: Study 2 – A Qualitative Multiple Case Study of Beliefs and Practices

5.1 INTRODUCTION

The purpose of Study 2 was to investigate the relationships among creativity, technology, and learning by exploring educational technology expert teachers' beliefs about and experiences with nurturing creativity in technology-integrated learning environments across six areas of the secondary school curriculum: EFL, Hungarian language and literature, mathematics, science, social studies, and visual arts.

Study 2 sought to answer the following research questions:

Q1: What characterizes Hungarian digital pedagogy expert secondary school teachers' beliefs about creativity?

Q2: What characterizes Hungarian digital pedagogy expert secondary school teachers' beliefs about nurturing creativity with technology in their subject areas?

Q3: What enablers and barriers do Hungarian digital pedagogy expert secondary school teachers perceive to stimulating students' creativity with technology?

Q4: What characterizes Hungarian digital pedagogy expert secondary school teachers' enactment of their beliefs about nurturing creativity with technology in the classroom?

Study 2 applied a multiple case study design to answer the research questions, involved 12 digital pedagogy expert teachers identified through purposeful sampling, and collected data using interviews, classroom observations, document, and image analysis.

Chapter 5 presents Study 2. It first discusses the multiple cases study methodology applied to answer the research questions posed (Section 5.2) and describes the findings that emerged from the methodological procedures (Section 5.3). Findings are then discussed and interpreted in relation to the existing body of literature on creativity, technology, learning, and teachers' beliefs and practices (Section 5.4). Chapter 5 ends with the conclusions drawn from Study 2 (Section 5.5).

5.2 QUALITATIVE MULTIPLE CASE STUDY METHODOLOGY

The section provides a detailed description of the methodology adopted in Study 2. First, the explanation of qualitative multiple case study design adopted for the research will be described (Section 5.2.1). Case selection and sample are outlined next (Section 5.2.2), which is followed by the description of data collection methods implemented in the Study 2 (Section 5.2.3). Data collection procedures and an explanation on how data were analysed are explained subsequently (Section 5.2.4 and Section 5.2.5). This is followed by an outline of the criteria used to judge the research quality (Section 5.2.6) as well as the ethical considerations pertinent to the Study 2 (Section 5.2.7). This section description ends with a summary of the research methodology implemented in Study 1 (Section 5.2.8).

5.2.1 Qualitative multiple case study design

In Study 2 a qualitative multiple case study approach has been chosen to achieve the purpose of exploring educational technology expert teachers' beliefs about and experience with nurturing creativity. Case-study as an approach to research is defined as an empirical inquiry investigating a contemporary phenomenon in-depth and within its real-world context especially used when the boundaries between phenomenon and context are not evident (Yin, 2014, p. 16). A case study approach underpinned by qualitative methodology is particularly applicable to the present study since it can provide in-depth knowledge on teachers' beliefs not obtainable by other means, as suggested by the findings in Study 1 as well as the in other relevant literature (Andiliou & Murphy, 2010; Fives & Buehl, 2012).

Depending on the methodological purpose they serve, case studies may be of different types. Yin (2014), for example, identifies three types of case study designs: descriptive, exploratory, and explanatory. A descriptive case study focuses on comprehensive descriptions about a phenomenon while considering possible theories to frame the study and questions. Exploratory case studies aim at exploring a particular phenomenon within its real context while investigating the relationships between contextual variables related to phenomenon at hand. An explanatory case study examines causality in the researched phenomenon. In Stake's (2006) classification, case studies can be intrinsic, instrumental, and collective. Intrinsic case studies are undertaken to

understand a specific case and are not used for theory building (Baxter & Jack, 2008; Stake, 2006). An instrumental case study can be conducted when the aim of the researcher is to build or refine a theory (Baxter & Jack, 2008; Stake, 2006). Collective case studies are groups of individual studies that are undertaken to gain a greater understanding of a certain phenomenon (Stake, 1995). Yin (2014) called this multiple case study design.

Study 2 adopted an exploratory case study of collective nature. A case was defined as one digital pedagogy expert teacher's technology-enhanced creativity fostering beliefs and their enactment. The research was exploratory because it investigated digital pedagogy expert teachers' beliefs about and experience with nurturing creativity within their real environments also considering influences of contextual variables. The research was collective since it replicated the research condition across multiple cases which facilitated the construction of contextualized experiences and systematic analysis procedures (Baxter & Jack, 2008; Stake, 2006; Yin, 2014).

5.2.2 Case selection and sample

In qualitative designs the goal of sampling is to identify information-rich cases that will allow the researcher to study a phenomenon in-depth (Creswell, 2013; Mertens, 2010; Patton 2002; Robson & McCartan, 2016). This goal is typically achieved by employing a purposeful sampling approach, which involves the purposeful selection of those participants whom the researcher believes will provide the best information about the situation under investigation (Patton, 2002). The selection of cases is thus based on their anticipated richness and relevance of information in relation to the study's research questions (Yin, 2011, p. 311). There are a variety of strategies available to the researcher for purposefully selecting participants and data sources that fit the goals of the qualitative study (Patton, 2002). Study 2 applied three of the selection strategies described in the literature: criterion sampling, stratified sampling, and maximum variation sampling (Patton, 2002) presented in detail below.

Case selection

The goal of purposeful sampling was to select participant teachers able to provide expert opinion on the use of technology for nurturing student creativity across the secondary school curriculum. The sampling unit was represented by individual teachers

and the data collected from them through interviews, classroom observation, document, and image analysis. Participant selection was guided by the combination of criterion, stratified, and maximum variance sampling (Mertens, 2010; Patton, 2002; Robson & McCartan, 2016). Criterion sampling requires the researcher to specify in advance a set of attributes, factors, characteristics or criteria that the study addresses (Mertens, 2010). The predefined selection criteria as well as the reasons for their application are detailed in the following Table 7.

After selecting potential participants based on the sampling criteria outlined in Table 7, the research applied a stratified sampling technique (Mertens, 2010; Patton, 2002; Robson & McCartan, 2016). Thus, potential cases were divided in six subgroups based on the teachers' main subject areas: arts, EFL, Hungarian language and literature, mathematics, science, and history. The sample of cases were then selected within these six strata by including two participants from each subject area into the final sample. Study 2 also applied the maximum variation principle: the researcher strived to include cases to maximize variation within the sample based on participants' background information such as school type, and the location of school where potential participants taught at the time of the study, their age, gender, teaching experience. This allowed the investigation of commonalities and differences in teachers' beliefs and experiences of nurturing creativity across diverse settings and personal characteristic.

The sampling strategy adopted yielded the identification of 12 digital pedagogy expert teachers to participate in the study. The sample size thus was in accordance with what the literature views as an appropriate size for the multiple case study approach, since the benefits of such approach might be limited if fewer than 4 cases are chosen or more than 15 (Stake, 2006, p. 22).

Sample

The final sample of Study 2 comprised of 12 digital pedagogy expert teachers nominated by educational technology stakeholders and selected through a combination of criterion, stratified and maximum variation sampling strategies as described in the previous section. The characteristics of the sample are presented in Table 8.

Table 7. Sample selection criteria in Study 2

Selection criteria	Reason
Must have been teaching at secondary school grade levels.	Less emphasis has been given to teachers' beliefs and practices of nurturing creativity in the secondary school context (Andiliou & Murphy, 2010; Study 1). The present study wished to fill the gap in the literature in this respect.
Must have been working as teachers for at least 5 years.	Research on teacher effectiveness suggests that teachers' effectiveness increases with experience (Kini & Podolsky, 2016). Study 2 aimed to explore expert opinions on creativity and technology, the sample, thus, had to comprise experienced and effective teachers.
Must have been teaching the following curricular areas: EFL, Hungarian language and literature, mathematics, science, social science, and visual arts.	The aim of Study 2 was to explore digital pedagogy expert teachers' beliefs and experiences of nurturing creativity focusing on five core subject areas of the high school curriculum: Hungarian language and literature, mathematics, science, history and a foreign language. Arts has been chosen for its special connection with creativity (Study 1)
Must have been recognized by other educational technology stakeholders as digital pedagogy experts based on the following performance criteria: (1) have earned a local, regional, state, or national award for teaching with technology, (2) have presented at local, regional, state, or national conferences on the topic, and/or have mentored younger teachers or teacher candidates on the topic, (3) have earned awards or grant funds related to digital pedagogy, (4) have received praise and positive feedback from parents, students, and colleagues for their technology-integrated teaching practice.	There is little benefit in seeking a random sample when this may be largely ignorant of particular issues and unable to comment on the phenomenon under investigation (Cohen, Manion, & Morrison, 2007, p.115). The purposeful selection of participants in Study 2 focused on teachers who excelled in the use of technology for teaching and learning. In line with the literature, technology was considered an element of the creativity-fostering learning environment (Davies, 2013). To gain relevant and rich information on the relationships among creativity, learning, and technology from practitioners, the researcher decided to include participants highly knowledgeable about technology-integrated learning who were also recognized by others for their expertise. The beliefs and practices of teachers selected this way could provide meaningful insights to nurturing creativity with technology in the classroom.

Table 8. Characteristics of the sample included in Study 2

Pseudonym	School	School type	School location	Subject taught	Age	Years of teaching experience	Academic background	Career stage	Post-graduate professional examination	Awards received
Anita (EFL1)	A	general lower and upper secondary	Urban	EFL	33	11-20 years	MA Degree	Teacher 1	no	Teacher of the year (school level)
Susan (EFL 2)	B	secondary vocational	Urban	EFL	52	21-30 years	MA Degree	Teacher 2	Educational Leadership	Award-winning digital pedagogy projects (international level)
Boris (SOC 1)	C	secondary vocational	Urban	Social science	29	6-10 years	MA Degree	Teacher 1	no	Best project award (school level) Instructor of the year (school level) Digital pedagogy project of the year (national level) Individual digital pedagogy award (national level) Digital pedagogy team award (national level)
Elisabeth (SOC 2)	D	general lower and upper secondary	Urban	Social science	49	11-20 years	MA Degree	Teacher 1	no	none
Judith (HUN 1)	E	vocational	Urban	Hungarian language and literature	59	more than 31 years	MA Degree	Teacher 2	Digital pedagogy	Digital pedagogy project award (national level)
Martha (HUN 2)	F	vocational	Urban	Hungarian language and literature	48	21-30 years	MA Degree	Teacher 1	no	Digital pedagogy project award (1 at national level, 2 at international level) Pedagogical innovation award (national level)

Table 8 (*continued*)

Pseudonym	School	School type	School location	Subject taught	Age	Years of teaching experience	Academic background	Career stage	Post-graduate professional examination	Awards received
Bill (MAT 1)	G	general lower and upper secondary	Urban	Maths	37	11-20 years	MSc Degree	Teacher 1	no	Digital pedagogy project award (national level and international level)
Rose (MAT 2)	H	secondary vocational	Urban	Maths	50	21-30 years	MSc Degree	Master teacher	Educational Leadership	Digital pedagogy project award (national level) Good practice featured on national digital pedagogy online repository
Ada (SCI 1)	F	secondary vocational	Urban	Science	50	21-30 years	MSc Degree	Master teacher	Mentor teacher	Digital pedagogy project awards (7 at national and 4 at international level)
Albert (SCI 2)	I	general lower and upper secondary / vocational	suburban	Science	51	21-30 years	MSc Degree	Master teacher	Educational Leadership	Digital pedagogy project award (national level) Innovation in education award (regional)
Robert (ART 1)	J	general lower and upper secondary	Urban	Visual Arts	36	11-20 years	MA Degree	Teacher 2	Educational Leadership	Best practice in gifted education and talent development awards (3 at national level) Teacher of the year (national level)
Zoey (ART 2)	K	general lower and upper secondary / vocational	suburban	Visual Arts	45	11-20 years	MA Degree	Master teacher	General	Digital pedagogy award (national level)

Participants in Study 2 were of both gender (8 female, 3 male) with ages ranging from 29 to 59 years (M_{age} = 44.92 years, SD = 9.05), and teaching at 11 different schools. In terms of teaching experience, one teacher had between 6-10 years of teaching experience, five between 11-20 and 21-30, while one had been teaching for more than 30 years at the time of the study. As for school location, ten teachers taught in schools located in urban areas, whereas two in suburban schools. With concern to the school type, four teachers worked in general lower and upper secondary schools, six in secondary vocational schools, whereas two in both general lower and upper secondary, and secondary vocational schools. All 12 teachers had obtained MA or MSc degrees, and were in different stages of their career: five teachers in Teacher 1 stage, three teachers in Teacher 2, and four teachers in the Master Teacher stage. Seven of the 12 participants had also taken post-graduate professional examinations: four in educational leadership, one in mentoring, one in digital pedagogy, and one in a general area. Except for one teacher (Elisabeth), all participants had received professional recognition in form of local, national, and/or international awards.

The 12 teachers participating in Study 2 also reported to have diverse experience in the areas of creativity education and digital pedagogy as illustrated by the following *Figure 11*.

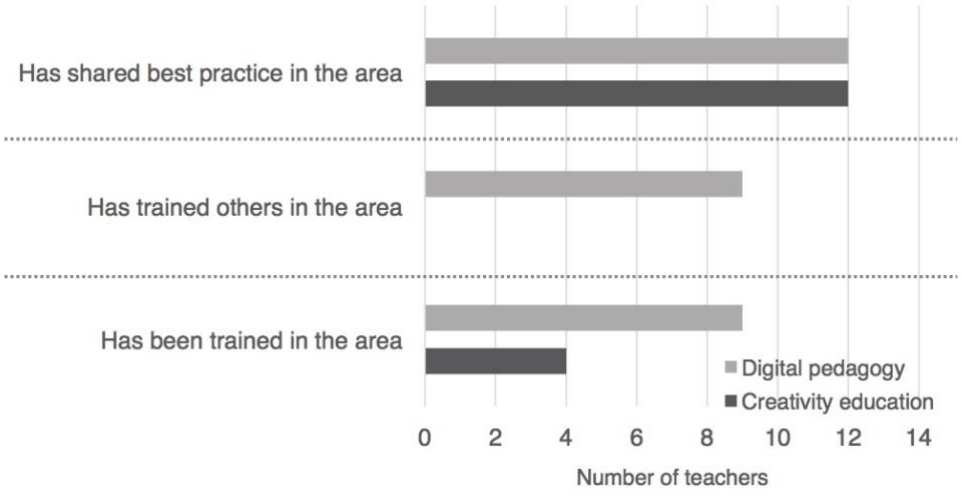


Figure 11. Participants' experience with creativity education and digital pedagogy in Study 2

5.2.3 Data collection methods and instruments

The application of multiple data collection methods in social science have several advantages. While examining a phenomenon through a single method may lead to a limited view of the social situation under investigation, the exploration of the same phenomenon using different methods can provide more details on the context (Cohen et al., 2007; Robson & McCartan, 2016). In addition, research methods have their own weaknesses, therefore, applying multiple methods and data sources can compensate for individual limitations and increase the strength of interpretations and conclusions in qualitative research (Guba & Lincoln, 1989).

Therefore, in Study 2 data have been derived from four different methods of data collection. Semi-structured interviews were conducted with digital-technology expert secondary school teachers to expose their views about nurturing creativity, while observations of these teachers' lessons sought to explore their beliefs-in-action. The analysis of researcher created images as well as the analysis of documents, such as lessons plans, project descriptions, student- and teacher-created artefacts aimed to provide further insights on teachers' understandings and meanings of creativity and its nurture through technology. The appropriateness of the methods employed in Study 2 as well as the reasons for their adoption are detailed below.

Semi-structured interviews (pre- and post-observation)

Interviews are considered the most significant data collection technique in qualitative research since they enable the researcher to explore people's views, experiences, understandings, meanings, interpretations, and perceptions of the reality. Three forms of interview have been commonly applied in educational research: fully structured, semi-structured, and unstructured (Cohen et al., 2007; Mertens, 2010; Robson & McCartan, 2016). A semi-structured interview relies on a guide with pre-determined topics, default wording and order, which can, however, be modified and supplemented with unplanned questions. With semi-structured interviews, the outline allows to collect comprehensive data adopting a more systematic approach yet maintaining the conversational and situational character of the interview (Cohen et al., 2007).

To obtain comprehensive nonetheless comparable data on digital pedagogy expert teachers' views about creativity and its promotion in technology-integrated learning

environments a series of face-to-face semi-structured individual interviews were conducted with the participants. Teachers were asked to take part in pre-observation and post-observation interviews. The pre-observation interview focused on the use of technology to promote creativity during the lesson to-be-observed (For the pre-observation guide see Appendix C). The post-observation interview aimed to explore teachers' pedagogical beliefs about creativity and its nurture, with special emphasis on the role of technology in fostering creativity within the specific subject area taught. The interview protocol and questions were developed based on the main themes identified in the research literature on teachers' beliefs about creativity and its nurture exposed by the Study 1 and on the analysis of the questions featured in the research instruments designed to explore teachers' beliefs about creativity in the empirical literature reviewed in Study 1. The post observation interview also allowed to further questions emerging from the pre-observation interview and the classroom observation (see Appendix E for the post-observation guide). Further information about the practical procedures used to pilot and conduct the interviews will be provided in a later section (Section 5.2.4).

Semi-structured participant observation

The distinctive feature of the observation technique is that it offers the investigator first-hand accounts of social situations. Observational data allows the researcher to understand the situation being described (Patton, 2002, p. 264). Observation is often applied as a supportive and supplementary method to complement or set in perspective data obtained through other techniques. Researchers particularly employ observation in conjunction with interview and questionnaire methods, since responses in these latter are notorious for the discrepancies between what people say that they have done or will do and their actual actions (Robson & McCartan, 2016).

In Study 2 the classroom observation technique was used to support and complement data emanating from individual teacher interviews. While pre-and post-observation interviews offered insights into teachers' self-reported views, understandings, experiences, and intents with regards to nurturing creativity in technology-integrated environments, classroom observations allowed data collection about teachers' beliefs in action (Fives & Buehl, 2012). Also, the post-observation interview permitted the researcher to ask clarifying questions as well as offered teachers the opportunity to construe issues emerging from the classroom observation.

Study 2 applied a semi-structured approach to observation. In contrast to a fully structured observation which uses data to test predetermined hypotheses, a semi-structured and unstructured observation is hypothesis-generating with the researcher reviewing observational data before suggesting explanations for the phenomena being observed (Robson & McCartan, 2016). The semi-structured observation applied in Study 2 focused on the details of what was happening in terms of teacher and student actions in time during the lesson, as well descriptions of how the physical and psychosocial environment looked (For the observation sheet see Appendix D).

The researchers' role in observation may range from that of a complete participant taking on an insider role in the group under investigation to one of a complete observer, an approach within which participants do not realize that they are being observed (Cohen et al., 2007). Beyond ethical and methodological considerations, the researchers' background also should be considered in role selection, since acceptance in the group may well be dependent on the researcher's age, gender, and ethnic background (Mertens, 2010). To gain a first-hand account of teachers' practices of fostering creativity in the classroom as an adult, yet to cause minimal disturbance I adopted the 'observer-as-participant' role, namely I was known as a researcher to the teacher and students participating in the observed lesson, but had less extensive contact with them.

Observation as a method tends to be very time-consuming, which has led to the design of more condensed field experiences in education research in recent years. One possible strategy to achieve such condensed experience of observation is for the participant researcher to evoke a specific situation or behaviour from the participants (Robson & McCartan, 2016). In Study 2, digital pedagogy expert teachers were asked to allow the researcher to observe one of their lessons which they specifically designed to promote students' creativity through the use of educational technology within their own subject areas. A major disadvantage of such an interventionist approach is that participants might act in a different way to please or placate the observer (Robson & McCartan, 2016). In Study 2 the fact that the observed lesson might not be illustrative of usual practice was considered, however, it was not considered a threat. Teachers' choices regarding the student group, the learning environments, the topic of the lesson, the teaching materials, methods and technologies applied, as well as the interactions among people and people's interactions with technology in the observed lesson offered several insights on how teachers may or would promote student creativity with technology in

their own contexts. Further information on the practical procedures related to classroom observations applied in the study will be detailed will be provided in a later section (Section 5.2.4).

Image analysis

Visual images can play a useful role in the process of social research in a variety of ways. Images can be produced by participants and used as data, found or existing images can be used as springboards for theorizing, images and objects are useful to elicit or provoke other data, images created can be used for feedback and documentation of the research process, and they are useful as a mode of interpretation and/or representation (Weber, 2008, p. 47). In Study 2 the method of classroom observation was complemented with researcher generated images of the learning environment in which the observed lesson took place. Rather than taken as an objective representation of the truth, images were considered to provide a particular view of reality (Robson & McCartan, 2016), and were integrated accordingly in the research process.

Document analysis

Qualitative research may also examine documents to get the necessary background of the situation and insights into the dynamics of everyday functioning (Mertens, 2010, p. 373). Document analysis can render more visible the phenomenon under study (Prior 2003, p. 87). Study 2 used document analysis to provide further insights into digital pedagogy expert teachers beliefs about creativity and its nurture through technology. Extant documents, both in paper and digital format were analysed. Participant teachers could share the planning document of the observed lesson with the researcher. In addition, teachers could also provide project descriptions, digital material created by themselves or by their students, which they thought were illustrative of their experience of nurturing creativity in technology integrated learning environments in their subject area.

An important drawback of using extant texts is that they may be highly biased and selective, since they were not intended to be regarded as research data but were written for a different purpose, audience, and context (Cohen et al., 2007). In Study 2, the documents provided by the participant teacher were analysed with an understanding of

the time, context, and intended use for which the materials were created as suggested in the literature (Mertens, 2010).

Demographic questionnaire

A paper-based demographic questionnaire was used in Study 2 which asked about participants' personal characteristics and provided the contextual information necessary to make comparisons between the cases. The demographic questionnaire included information about teachers' gender, age, the type of school they taught in, teaching experience, subjects taught, awards, and past experiences with nurturing creativity and technology. For the demographic questionnaire used in this study see Appendix F.

5.2.4 Procedure and timeline

Conducting Study 2 required the arrangement of a series of practicalities. Preparations for data collection, the attainment of ethical clearance, the selection of participants, gaining access to study sites, acquiring participant agreement, devising a schedule for fieldwork were steps which ensured the appropriateness and ethicality of data collection stage. The following sections will provide information about three key procedures involved in fieldwork: developing and piloting data collection instruments, gaining access to sites and securing permissions, and applying the data collection methods and instruments.

Piloting the research methods and instruments

The first stage of any data gathering is piloting the methods and instruments the researcher has planned to use in the study (Cohen et al., 2007; Mertens, 2010; Robson & McCartan, 2016). Piloting ensures that the design and instruments the researcher proposes will generate analysable data relevant to the purpose of the study (Bazley, 2013).

Thus, the researcher conducted a pilot case study. The teacher involved in the pilot study was the researcher's colleague who met all the sample selection criteria: she had more than five years teaching experience at the time of the study, taught Hungarian language and literature at secondary level, had applied various educational tools in her lessons, had shared her expertise with other teachers at the school level, as well as at

national and international levels, and had been awarded for her work in the area of digital pedagogy. The pilot study contributed to revising instruments and addressing possible difficulties in the data collection process. For example, the teacher participating in the study highlighted some ambiguous questions which were modified in terms of meaning and wording. Another benefit of the pilot was that it helped to decide how much time should be dedicated to each main topic in the interviews and estimate their lengths.

Recruitment, permissions and access

Carrying out Study 2 required several approvals and permissions. First, the researcher requested ethical clearance from the Research Ethics Committee of the Eötvös Loránd University, Faculty of Pedagogy and Psychology. Once the ethical clearance was approved, the researcher contacted educational technology experts from the Eötvös Loránd University and Hungarian organizations promoting the use of educational technology to recommend potential teacher participants for Study 2 in accordance with the sampling criteria outlined in Section 5.2.2. Based on these recommendations a table was compiled containing recommended teachers' names, primary subject areas, email addresses, schools, school locations, principles' names. The scope of this table was to aid the second sampling stage, which followed the of maximum variance as outlined in Section 5.2.2, and to assist research management process. Selected teacher participants were then contacted and informed about the study through an information leaflet. Next, the researcher sent emails to the principals of those schools in which the teachers who agreed to participate worked, asking for permission to conduct the study. After principals' verbal consent, the researcher brought the site permission form, teacher consent form as well as the student and parent forms to the schools. The researcher also maintained constant email and phone communication with participant teachers to schedule fieldwork and clarify any arising issues. The communication with participants also helped the researcher the gain participant teachers' trust.

Fieldwork

Data for Study 2 were collected over a period of four months in the spring and summer of 2017, and autumn 2018. After piloting the study instruments and securing access and permissions, the researcher started the main data collection stage. Data were

collected from 12 digital pedagogy expert teachers selected to participate in the study by the procedures described in Section 5.2.3. A graphic representation of the data collection process from each teacher is provided in the following *Figure 12*.

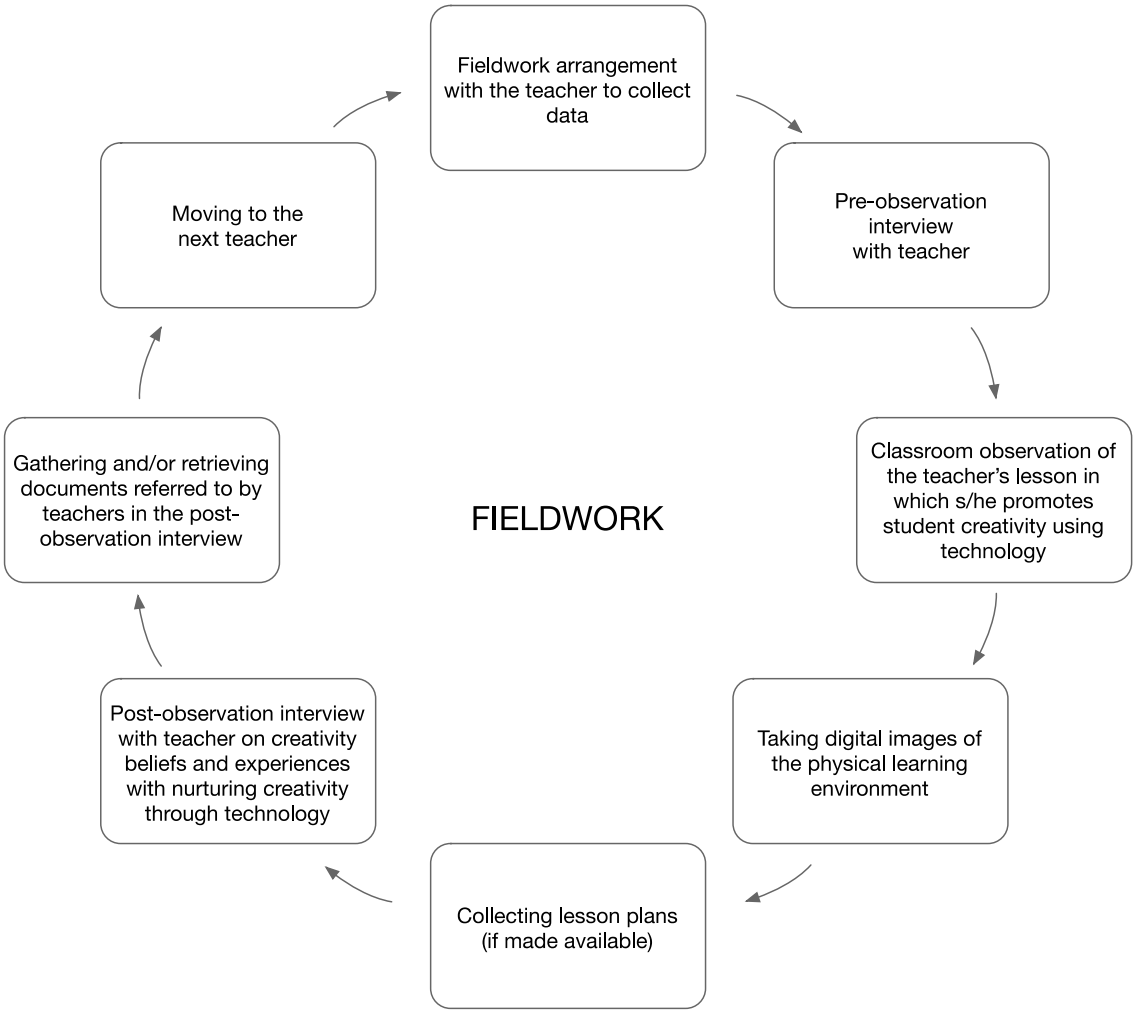


Figure 12. Data collection process in Study 2

Each data collection method used during Study 2 was guided by a separate protocol to ensure that the ethical and methodological principles were met. In total 24 interviews were conducted with teachers following the Pre- and Post-Observation Protocols developed for this research (see Appendix C and Appendix E). Pre-observation interviews lasted on average about 18 minutes, while the post-observation interviews took about 60 minutes. Both types of interviews were conducted face-to-face in teachers' schools, apart from one teacher who preferred to be interviewed after the observed lesson in a nearby café. The language of the interviews was Hungarian and the interviews were audio

recorded. Information about the pre- and post-observation interviews are detailed in the following Table 9.

Table 9. Details of the pre-and post-observation interviews in Study 2

Interviewee	**Pre-observation interviews**			**Post-observation interviews**		
	Duration	*Place*	*Mode*	*Duration*	*Place*	*Mode*
Anita	15 mins	classroom	face-to-face	39 mins	cafe	face-to-face
Susan	20 mins	office	face-to-face	60 mins	classroom	face-to-face
Boris	20 mins	comp. lab	face-to-face	60 mins	comp. lab	face-to-face
Elisabeth	21 mins	office	face-to-face	33 mins	office	face-to-face
Judith	18 mins	comp. lab	face-to-face	57 mins	comp. lab	face-to-face
Martha	19 mins	comp. lab	face-to-face	48 mins	park	face-to-face
Bill	17 mins	classroom	face-to-face	33 mins	office	face-to-face
Rose	22 mins	office	face-to-face	52 mins	office	face-to-face
Ada	18 mins	office	face-to-face	57 mins	laboratory	face-to-face
Albert	15 mins	classroom	face-to-face	70 mins	classroom	face-to-face
Robert	12 mins	classroom	face-to-face	40 mins	classroom	face-to-face
Zoey	17 mins	art room	face-to-face	57 mins	art room	face-to-face

In Study 2, 11 classroom observations were conducted. Teachers were asked to teach a 45-90-minute class period in which educational technology tools were used to stimulate students' creativity. The class period was carried out as part of the regular classroom practice at a time that suited the teachers' timetable and curriculum. The class was observed by the researcher, who collected data through note taking using the Classroom Observation Protocol (see Appendix D). At the end of each observation the researcher took three images of the physical learning environment in which the observed lesson was conducted, and which were used in conjunction with the observation notes in the analysis. General information about the observed lessons are contained in the following Table 10.

Table 10. General information about the observed lessons in Study 2.

Teacher	Grade	Subject	Topic	Duration
Anita	11th	EFL	Speculating about people and places	45 mins
Susan	9th	EFL	Culture: English speaking countries (Review)	45 mins
Boris	9th	history	The middle Ages (Review)	45 mins
Elisabeth	8th	history	Introduction to the Napoleonic Era	90 mins
Judith	11th	language arts	Drama: The Tragedy of Man	90 mins
Martha	11th	language art	Symbolism	90 mins
Bill	11th	maths	Analytic geometry equations (Review)	45 mins
Rose	9th	maths	Inequalities (review)	45 mins
Ada	9th	physics	Motion	180 mins
Robert	10th	visual arts	Leonardo da Vinci	45 mins
Zoey	10th	visual arts	Renaissance	45 mins

In total 17 documents were collected from teachers including lesson plans, project descriptions, digital material considered by participants to be illustrative of their experiences of nurturing creativity in technology integrated learning environments in their subject area. General information about the documents collected from each participant are detailed in the following Table 11.

Table 11. General information about the collected documents in Study 2

Pseudonym	Document abbreviation	Characteristics	Type
Anita (EFL 1)	Doc 1.	extant, private, full access, electronic, text	Lesson plan
Susan (EFL 2)	Doc. 1	extant, private, full access, paper-based	Student-created handouts
Martha (HUN 1)	Doc. 1	original, public, partial access, online, multimedia	Teacher website featuring project descriptions and students work

Table 11 (*continued*)

Pseudonym	Document abbreviation	Characteristics	Type
Judith (HUN 2)	Doc 1.	original, public, full access, electronic, online and downloadable, text and hyperlinks	Project plan
Rose (MAT 2)	Doc. 1	original, private, full access, electronic, text and hypertext	Unit plan
	Doc. 2	original, private, full access, electronic, text and hyperlinks	Project plan
	Doc. 3	extant, private, full access, electronic, text	Lesson plan
Ada (SCI 1)	Doc. 1	original, public, full access, online, text and hyperlinks	Project plan
	Doc. 2	original, public, full access, online, text and hyperlinks	Project plan
	Doc. 3	original, private, full access, online, multimedia	Students' project portfolio
Albert (SCI 1)	Doc 1	original, public, full access, online, text and hyperlinks	Project plan
Elisabeth (SOC 1)	Doc 1.	original, public, full access, online, multimedia	School website featuring project descriptions and students work
Boris (SOC 2)	Doc. 1	original, public, full access, electronic, online and downloadable, text and hyperlinks	Project plan
Robert (ART 1)	Doc. 1	extant, private, full access, paper-based	Teacher-created handouts
Zoey (ART 2)	Doc. 1	original, public, full access, electronic, online and downloadable, text and hyperlinks	Project plan
	Doc. 2	original, public, full access, online, multimedia	Project website featuring student work

5.2.5 Data analysis

The challenge of qualitative analysis lies in how the researcher can make sense of massive amounts of data (Patton, 2002, p. 432). Qualitative data analysis refers to the classification and interpretation of linguistic or visual materials to make statements about the explicit and implicit dimensions and structures of meaning-making in the materials and what they represent (Flick, 2014, p. 5). Qualitative data analysis is appropriate if the researcher wants to describe a phenomenon in detail focusing on an individual case or on comparing several cases, to look for explanations for differences between cases, and/or to develop a theory of the phenomenon under study from the analysis of empirical material (Flick, 2014, p. 5).

Data analysis in qualitative research involves several analytic stages. (Bazeley, 2013; Creswell, 2013; Miles, Huberman, & Saldaña, 2014; Robson & McCartan, 2016). The following section will explain the three fundamental stages of qualitative analysis applied (data preparation, management, and display) informed by the publications of Huberman, Miles and Saldaña (Miles & Huberman, 1994; Miles et al., 2014; Saldaña, 2013) and influenced by Bazeley's (2013) approach. Data analysis in Study 2 was assisted by the qualitative data analysis software Atlas.ti 8.3.1 for Mac.

Data preparation

In qualitative research, any work done with the data has analytic consequences. During data preparation and management, the researcher is prompted to think about the evidence collected in the field, while the way data is managed impacts the efficiency and effectiveness of analysis (Bazeley, 2013). Data may also come in in different forms, each requiring different approaches to data preparation and management (Flick, 2014).

In Study 2, data were drawn from interviews, classroom observations, document and image analysis, and prepared for further analysis in various ways. Individual interviews conducted with teacher participants were audio recorded and transcribed verbatim into word processing documents. To provide a reconstructable account of the lessons observed, handwritten notes taken on site using the observation sheet were recorded in a word processing document soon after the observation took place. With the analysis of documents, images, and web-based sources it is highly relevant, who created them, for whom, and for what purposes (Flick, 2014). These details were recorded by

each source. In addition, electronic documents were turned into word processing documents, paper documents were scanned. All electronic data files prepared in this stage were stripped from identifiers, labelled by participant pseudonyms and data collection methods, and imported into Atlas.ti 8.3.1 for Mac for further analysis.

Coding

Coding in Study 2 was informed by the coding framework and procedures proposed by Miles et al. (2014) and involved two major cycles, namely first-cycle (initial coding) and second-cycle (pattern coding).

First, the researcher carried out the first-cycle coding. Data from interviews, observations, document, and image analysis were broken down into distinct parts, which were then examined closely and compared for similarities. Two types of coding methods were used in this coding cycle: descriptive, and In Vivo. Descriptive codes refer to labels assigned to data to summarize in a short phrase the topic of a segment of the data, which was especially helpful for the present study using different data forms. Descriptive coding allowed to create an inventory of topics for indexing and categorizing in Study 2. First cycle-coding in Study 2 also included *In Vivo coding*. In Vivo coding uses the exact words or phrases of the participants in the data record as codes. The researcher used this type of coding to prioritize and honour participants' voice. While the purpose of first-cycle coding was to summarize segments of data, second- cycle coding, or pattern coding was carried out to group those summaries into a reduced number of categories, themes, and constructs.

During the whole coding process the researcher kept analytic memos which were used to document how the coding was developing (Saldaña, 2013). Analytic memos also triggered deeper reflections on the part of the researcher on the meaning of data and constituted a transitional phase from coding to report on the study.

Displaying the data

As with data preparation, the creation and use of data displays also represent an integral part of the analytic process. In this stage the researcher produces a compressed assembly of information which allows conclusion drawing and further action (Miles et al., 2014). There are numerous ways to move from codes, categories, and themes to the

final display of data while core to them is systematic work and adherence to logic (Bazeley, 2013; Creswell, 2013; Miles et al., 2014; Robson & McCartan, 2016). Study 2 used two of the data display approaches proposed by Miles et al. (2014). Matrix displays in form of charts and tables allowed to organize the material into an at-a-glance format for reflection, verification, and conclusion drawing. Narrative descriptions in turn provided a prosaic representation and presentation of findings.

Finally, data were also analysed and organized based on the techniques of within-case and cross-case analysis. A primary purpose of within-case analysis was to describe, understand, and explain what has happened in a single, bounded context. The examination of similarities and differences across cases during the cross-case analysis helped me develop more sophisticated descriptions and explanations (Baxter & Jack, 2008; Stake, 2006; Yin, 2014).

5.2.6 Research quality: Trustworthiness

In qualitative studies trustworthiness is the measure of research quality (Lincoln & Guba, 1985). Trustworthiness refers to the extent to which the data and data analysis are believable and trustworthy. There are several criteria along which the trustworthiness of a qualitative study can be enhanced and these traditionally include credibility, transferability, dependability, and conformability - constructed parallel to the postpositivist criteria of internal and external validity, reliability and neutrality (Creswell, 2013; Lincoln & Guba, 1985; Mertens, 2010). In the following sections, each criterion is discussed along with the steps taken by the researcher to improve the quality of the present study.

Credibility

Credibility is the most important indicator of trustworthiness in qualitative research (Guba & Lincoln, 1989). In Study 2 credibility was achieved in several ways. First, methods triangulation (Denzin, 1978) was used to check the congruence of findings across data collected through individual interviews, observations, document, and image analysis. Source triangulation (Denzin, 1978) was also applied, since data was collected with the same method from different participants. Second, member checks (Lincoln & Guba, 1985) were incorporated at different points of the analysis process: for example,

interview transcripts, classroom observation summaries were sent to participants for inspection at the beginning of the analysis; the researcher also asked participants for clarifications as well as discussed interpretations with them throughout the process of meaning-making. Third, referential adequacy (Lincoln & Guba, 1985) was examined by archiving one interview and observation data and analysing it subsequently to test the congruence of findings drawn from the rest of the data. Fourth, Study 2 used peer briefs during which the researcher consulted with other two researchers with regard to the analysis and interpretation. Finally, the criteria for prolonged engagement (Lincoln & Guba, 1985) was partially met, since the researcher spent four hours with the participants, however communicated with them extensively online prior to the personal meeting, thus establishing a relationship of trust and developing rapport with them. The previously described practices thus may considerably increase the credibility of the findings reported in Study 2.

Transferability

Transferability represents the qualitative parallel to external validity. In post-positivist research, external validity concerns the generalizability of findings to populations from which the representative sample has been drawn (Mertens, 2010). Since qualitative inquiries are often very specific with their findings germane to particular individuals, situations, and environments, the criterion of external validity is not applicable to them. Instead, qualitative researchers strive for the transferability of their findings to other contexts. This can be achieved by describing a phenomenon in sufficient detail, so that others can evaluate the extent to which the conclusions drawn are transferable to other times, settings, situations, and people (Lincoln & Guba, 1985, p. 360). The extensive and careful description of the context is known as 'thick description' (Geertz, 1973).

To achieve transferability in Study 2, I sought to provide a 'thick description' of the context of investigation by collecting extensive demographic information, such as participants' background, time, contexts, locations, thus allowing the reader to determine the degree of similarity between the present study's sites and the receiving one.

Dependability

Dependability in qualitative research is analogous with reliability which refers to the consistency of observing the same findings under similar circumstances (Lincoln & Guba, 1985). The dependability criterion can be met through inquiry auditing in which another researcher examines both the product and process of the research to attest the quality and appropriateness of the inquiry (Lincoln & Guba, 1985; Mertens, 2010). Dependability audits are possible if the investigator provides a detailed description of how data were collected, how categories were derived, and how decisions were made throughout the inquiry (Merriam, 1998).

To ensure dependability in Study 2 I provided a detailed description of the research process. In addition, an inquiry audit was carried by my advisor resulting in subsequent clarifications added to the report.

Conformability

The concept of conformability in qualitative research parallels the quantitative criterion of objectivity. Steps should be taken by the qualitative investigator to ensure that conclusions are based on the experiences and ideas of informants rather than on the researchers' own values and imagination. The interpretation, therefore, should follow a clear logic formulated in ways consistent with the available data (Guba & Lincoln, 1989).

In Study 2 conformability has been achieved through peer debriefing. The researcher asked another educational researcher with PhD to code and analyse the transcript of a teacher interview and the notes of a classroom observation. The comparison and discussion of the individual results revealed similar codes and interpretations. The few discrepancies found were discussed helping the researcher confront her own values and guiding the next steps in the study, as it was indicated in the literature (Mertens, 2010).

5.2.7 Ethical concerns

Ethical considerations are associated with this research, since the process of inquiry has involved interviewing and observing human beings. Throughout the study great care has been taken to avoid any harm to participant teachers and students. In this regard, a

comprehensive ELTE PPK Ethical Clearance Application was submitted and approval was gained. The two most important ethical aspects considered for Study 2 were acquiring informed consent and securing confidentiality described in the following sub-sections.

Informed consent

Consent assures the protection and respect of the right of self-determination of participants in a research study. It is the procedure in which individuals chose to participate or not in an investigation after being informed of the facts that would likely influence their decision (Cohen et. al, 2007, p. 52). In Study 2 this information was provided to potential participants including teachers and students, as well as to parents and school administrators, through the consent forms and discussions outlining the purpose of the study, data collection methods as well as the extent, nature, and duration of the participation required.

Anonymity and confidentiality

Anonymity and confidentiality are both concerned with participants' right to privacy. The essence of anonymity is that information shared by participants will in no way reveal their identity (Cohen et al., 2007, p. 52). To assure the anonymity of the students involved in the study no individual data was collected from them during classroom observations. Since data collection was based on the personal interaction between the researcher and participant teachers during the interviews and classroom observations, full anonymity could not be guaranteed to them in this study. The individual privacy of these participants was then protected through confidentiality.

The essence of confidentiality is that although the researcher knows who has provided the information and can identify participants from the information given, she will in no way make the connection known publicly (Cohen et al., 2007, p. 65). Confidentiality was ensured in several ways in this study: all data were stripped of any identifiable information, pseudonyms were used instead of real name, alphabet letters were used to refer to schools, confidential information was not included in transcripts or the present research report. The meaning and limits of confidentiality in relation to study were explained to the participants in the consent forms and during the consent discussions.

5.2.8 Section summary

The section provided a detailed description of the methodology adopted in Study 2. The next section presents the findings that emerged from the analysis of data.

5.3 RESULTS

This section presents the findings of qualitative multiple case studies conducted to investigate the relationships between creativity, technology, and learning by exploring educational technology expert teachers' beliefs about and experiences with nurturing creativity in technology-integrated learning environments across six areas of the secondary school curriculum: EFL, Hungarian language and literature, mathematics, science, social studies, and visual arts. Results are structured along the four research questions asked by Study 2. Section 5.3.1 addresses findings pertaining to research sub-question **Q1:** What characterizes Hungarian digital pedagogy expert secondary school teachers' beliefs about creativity? Section 5.3.2 describes finding in relation to research sub-question **Q2:** What characterizes Hungarian digital pedagogy expert secondary school teachers' beliefs about nurturing creativity with technology in their subject areas? Section 5.4.3 details findings with reference to research sub-question **Q3:** What enablers and barriers do Hungarian digital pedagogy expert secondary school teachers perceive to stimulating students' creativity with technology? Section 5.4.4 presents results in connection with **Q4:** What characterizes Hungarian digital pedagogy secondary school teachers' enactment of their beliefs about nurturing creativity with technology in the classroom? This section ends with a summary (Section 5.3.5).

5.3.1 Teachers' beliefs about the nature of creativity (Interviews)

Teachers' beliefs about creativity guide their practices of fostering students' creative capacities with technology in classroom. Teachers in this study discussed a range of beliefs they held about creativity. Key beliefs identified from the interview data fell into the following categories: teachers' meanings of creativity (Definition), what teachers think about the relationship of creativity with school subjects and grade levels (Specificity), and what teachers believe about the nurture of creative potential, and its

measurement (Malleability). For a thematic map of teachers' beliefs about creativity see *Figure 13*. For of a complete coding analysis of the interview transcripts with reference to teachers' beliefs about creativity, including the frequency of responses for each theme and subtheme see Appendix G.

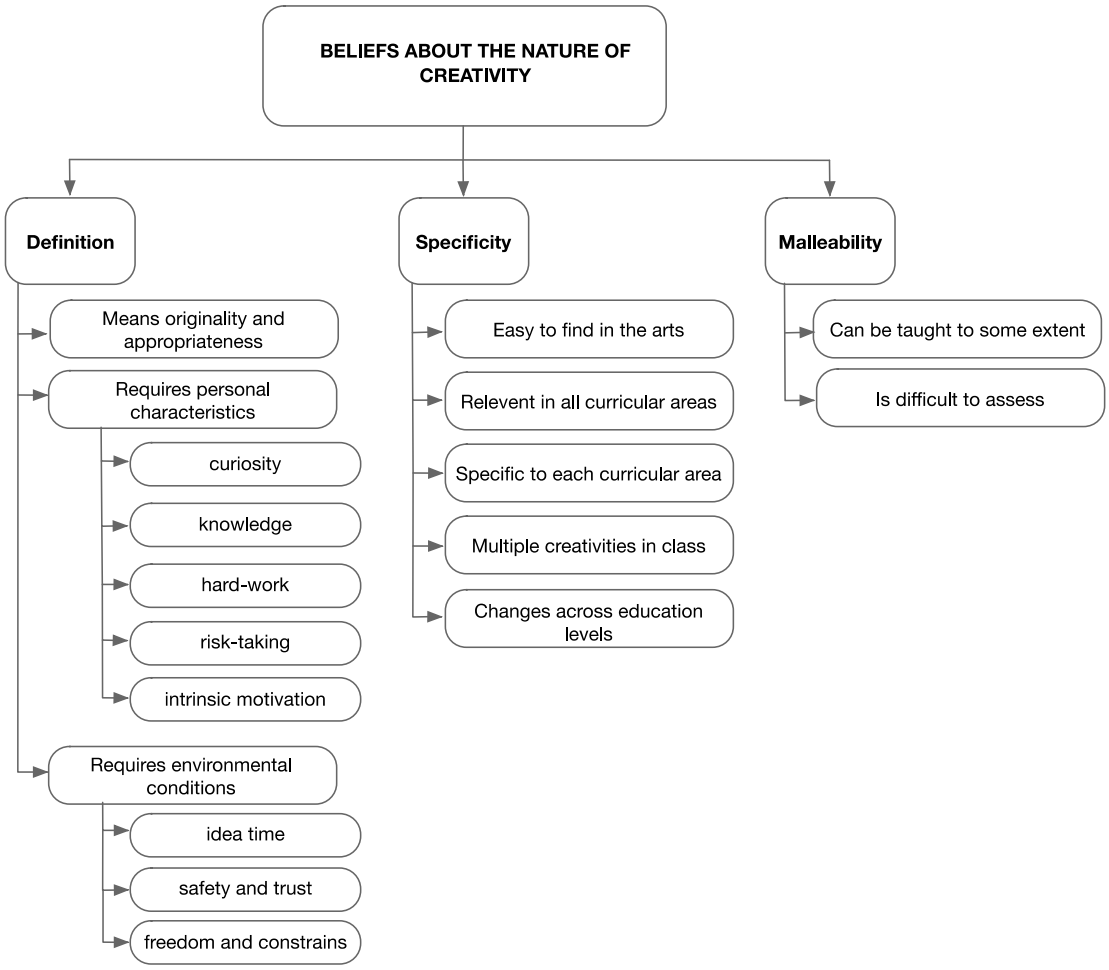


Figure 13. Thematic map of digital technology expert teachers' beliefs about the meaning of creativity in Study 2.

Definition

Data analysis revealed that all technology expert secondary school teachers in the study were able to provide a definition for creativity with only two participants indicating that the concept was hard to define. When discussing creativity, participants often referred to it in terms of process, product or a persons' ability. Creativity has also been conceptualized in various contexts throughout the interviews: creativity in everyday life, teachers' creativity in the classroom, professionals' creativity in the domains related to

the subject areas taught, but mostly referring to secondary students' creativity. The analysis of data showed that teachers conceptualized creativity through addressing its chief components, namely through the characteristics of the creative product (originality, appropriateness), person (curiosity, knowledge, hard work, risk-taking, intrinsic motivation, and imagination) and environment (idea time, safety and trust, balance between freedom and constrains). The following Table 12 provides an overview of teachers' beliefs about the meanings of creativity featuring the number of respondents and comments for each theme.

Table 12. An overview of teachers' beliefs about the meaning of creativity in Study 2

Theme	Subtheme	Nr. of respondents	Total comments
Means originality		12	20
Means appropriateness		12	15
Requires certain personal characteristics		12	45
	curiosity	9	12
	knowledge	7	11
	hard work and commitment	7	10
	risk-taking	7	7
	intrinsic motivation	5	5
Requires certain environmental conditions		12	65
	idea time	11	28
	safety and trust	6	16
	freedom	9	12
	constrains	6	9
Totals		**91**	**145**

Creativity means originality

Digital pedagogy expert secondary school teachers participating in the multiple case study shared the view that originality is a fundamental element of creativity. They tended to define creativity as something new, interesting, different, unique, unusual, or non-schematic. Ada, for example, stated that "Creativity happens when somebody overcomes schematic thinking and produces something new and personal" (Ada, Int. 2). Similarly, Rose defined creativity as referring to "interesting solutions, unique approaches, making connections between things which are unusual to connect" (Rose, Int. 2). For Zoey "creativity always refers to something that is different, outside the box" (Zoey, Int. 2).

Teachers' subject-specific conceptualizations of creativity also emphasised the original aspect of creativity. According to Anita, "creativity in language means that I can express myself in different ways, or I express myself in unusual ways" (Int. 2.). Bill argued that in mathematics creativity meant approaching or solving problems in unique ways: "Creativity is when students approach problems off the beaten path, and find unique approaches, or make connections which did not exist before" (Int. 2)

Thus, indifferent of the level or the domain in which the term has been conceptualized, all teachers in this study perceived creativity as originality, which, however, was not seen as the sole condition for judging creative outcomes.

Creativity also means appropriateness

In addition to originality, all teachers in this study recognized appropriateness as a requirement for creativity. Appropriateness as a requisite of creativity appeared in some teachers' definitions of the concept. In Zoey's view creativity meant "the production of workable solutions appropriate to the situation, requirements, or circumstances at hand" (Zoey, Int. 2). Anita commented that "creativity involves the production of multiple correct answers, and there is not only one good way of solving a problem" (Anita, Int. 2).

Other teachers mentioned appropriateness as an element of creativity in several other contexts across the interviews. For example, Martha emphasised usefulness of creative outcomes in connection with the characteristics of creative students, who "have lots of ideas and are capable of selecting those which they can use" (Martha, Int. 2). Discussing the role of creativity in her subject, Ada said that "most students won't study science later, but will need to solve unexpected situations in their everyday lives using what they have learnt and finding solutions which are good for them" (Ada, Int. 2). Robert suggested that students could manifest their creativity in all art-related subjects taught by him "depending on the nature of the task the students need to solve" (Robert, Int. 2). With regard to the assessment of creative outcomes, Elisabeth mentioned that "it is important for students to learn that it is not good if something is all glittery, but otherwise a flim-flam" (Elizabeth, Int. 2).

Overall, all secondary teachers in this study appeared to be aware that originality and task appropriateness are joint requirements for creativity.

Creativity requires certain personal characteristics: curiosity, knowledge, hard work, risk-taking, intrinsic motivation, and imagination

Teachers in the current study identified several personal characteristics as necessary for creativity. Most teachers (9) argued that curiosity, interest, passion are closely connected to creativity. Albert, for instance held the view that "there is no creativity without curiosity", and that "curiosity drives creativity" (Albert, Int. 2). Zoey held a similar belief and argued that "creative students are above all curious. They want to see behind things, and are interested in what and why things happen" (Zoey, Int. 2).

Other three characteristics addressed by more than half of the teachers were knowledge (7), commitment and hard work (7), and willingness to take risks (7). Several secondary teachers emphasized the need for a certain amount of domain knowledge for creativity. Rose, for example, stated that "some knowledge is necessary for creativity and creative thinking" (Rose, Int. 2). Boris highlighted that creativity could manifest in the classroom when students have some basic knowledge in the subject:

> For creativity, a certain amount of knowledge is necessary. You cannot be creative in the subject area without that. The amount of the knowledge is, however, important: you don't need a lot of knowledge to be creative. (Boris, Int. 2)

The importance of commitment and hard work in the creative process, was, for example, explained by Albert, who discussed it along with curiosity, risk-taking and knowledge:

> Overall, I think creativity requires interest, perseverance, some knowledge, and it is absolutely important to help students develop those skills. (Albert, Int. 2)

Willingness to take risks was another important characteristic indicated by teachers as needed for creativity. Zoey expressed this idea as follows "Creative students dare to go against the flow, and can show me that yes, they want something else, dare to think differently, have the courage to share a personal approach, this is what creativity is for me" (Zoey, Int. 2). Finally, intrinsic motivation (5) and imagination (4) were also cited by teachers as necessary for creativity in the classroom.

Thus, digital pedagogy expert teachers in this study seemed to be aware of several important personal attributes necessary for creativity, with many also recognizing the importance of cultivating such characteristics in the secondary classroom.

> *Creativity requires certain environmental conditions: idea time, safety and trust, balance between freedom and constrains*

In addition to the creative person aspect, secondary school teachers in this study also recognized several environmental conditions necessary for creativity. The most widely cited among these was idea time mentioned by the majority of teachers (11). Anita, for example, commented, that you cannot expect students to be creative if "you ask them to come up with three creative ideas now". Boris also explained that "in a creativity-stimulating environment, time to discuss ideas was essential" (Int. 2).

Another recurrent characteristic of a creativity-conducive environment reported by nine teachers was freedom. In addition, six participants also highlighted that freedom and constrains should be balanced in a creative environment. Freedom and constrains were discussed in relation to task requirements as well as referring to the choices students are offered in their learning. For example, Judith commented that students could be creative "in a guided way" or could "be given total freedom" (Int. 2). Anita defined creativity itself as "freedom under constrains" (Int. 2), Albert argued that "students should not be constrained to one path, but there are certain educational goals that need to be reached some time" (Int. 2).

Finally, safety and relationships based on trust and mutual respect were also viewed by six teachers as elements of the environment in which creativity could manifest. In addition, establishing an environment characterized by safety and tolerance was often considered to be an important responsibility of the teacher. Anita explained this as follows:

> It's extremely important to be OK to make mistakes […] And the teacher, isn't only a teacher, but also a member of the community. Let's listen to each other, let's think about the answers, how can this answer be true. We should accept it if someone has a different opinion, and that still can be good. Let's praise each other, let's be careful with giving feedback. (Anita, Int. 2).

Overall, teachers in this study seemed to be aware of the important role of the environment in creativity also recognizing their own responsibility of establishing creativity-stimulating conditions.

Specificity

In addition to discussing creativity in more general terms, participants were also prompted to express their beliefs regarding the relationship of creativity with school

subjects and education levels. Emerging themes in this respect included the idea that creativity is easier to find in the arts, is relevant to all subjects, varies across curricular areas, multiple creativities may occur within one subject area, and that creativity changes across education levels. The following Table 13 offers an overview of teachers' beliefs about the specificity of creativity along with the number of respondents and comments for each emerging theme.

Table 13. An overview of teachers' beliefs about the specificity of creativity in Study 2

Theme	Nr. of respondents	Total comments
Easy to find in the art-related subjects	6	7
Relevant in all curricular areas	12	22
Specific to each curricular area	12	54
Multiple creativities may manifest in the classroom	6	8
Changes across education levels	10	35
Totals	**36**	**91**

Creativity is easy to find in the art-related subjects

Data analysis indicated that secondary teachers viewed art as an area in which creativity could easily and naturally manifest. Elisabeth, who teaches history, for example, stated that "creativity can be more easily used in art-related subjects", at the same time stating its relevance across the whole curriculum (Elisabeth, Int. 2). One of the EFL teachers commented that "when you hear the word creativity, you first think of artistic creation, but I believe creativity is not [only in the arts]" (Anita, Int. 2). When asked about her first ideas on creativity, Ada, the science teacher, responded that:

> I would associate it [creativity] with a concept related to the arts, primarily drawing, sculpture or music, though in the latter there are more constrains. But in reality, anyone can be creative. Cooking, for example, can be creative, it's just that not everyone uses their creativity in this area, but instead people choose schemas, tried and trusted things. (Ada, Int 2.)

Overall, though six teachers discussed creativity in terms of art, these teachers also emphasized the fact the creativity can generally be applied to any subject, and specifically to their own.

Creativity is relevant but may not manifest to the same extent across the curriculum

Educational technology expert secondary school teachers all shared the view creativity can be applied to every subject of the secondary curriculum. Judith, for example, thought that creativity is inherent in the language arts, her own subject, but considered it similarly important in other areas, too.

> Of course, I first associate creativity with arts and humanities [her own subjects], but I believe it is similarly important in science. […] If I were a chemistry teacher and thinking about this, I am sure I'd have a ton of ideas about how it can be used there. (Judith, Int. 2)

The extent to which creativity manifested across the curriculum was thought, nevertheless, to depend on different factors. For example, Anita believed that creativity was relevant to all subject areas, underscoring teachers' role in nurturing it across the curriculum: "I don't think that there are subjects which lend themselves to a lesser extent to creativity, it is just a question of the pedagogical culture in Hungary" (Anita, Int. 2). Boris also believed that teachers had a responsibility in infusing creativity into their lessons, explaining at the same time that actual classroom practices were often mitigated by external factors.

> I believe that each subject can accommodate creativity, it depends on the teachers the extent to which they can infuse creativity in the lessons, which of course depends on the number of classes they have per week, and their other tasks. (Boris, Int. 2)

In addition to emphasising the relevance of creativity across the curriculum, most teachers widely acknowledged the role of creativity in their own subject area. Rose, for example, argued that nurturing logical creativity is one of the most important goals of teaching mathematics. Albert described the place of creativity in physics as follows:

> It's absolutely important. I believe that physics is a poster child for creativity. Where, if not in physics? Because physics is based on experimenting, and if we don't look at physics as a school subject, but as a domain, it involves building hypotheses which we test, or creating models and evaluating them […] Well, I believe that physics as a subject also involves the same, only at a smaller scale (Albert, Int. 2).

There was only one teacher, who expressed the view that creativity was more difficult to apply to her own subject area (history), arguing, nevertheless, for its relevance in certain aspects of the discipline: "In history there are some constrains, there are facts,

and you cannot be creative with facts. With history, I think, it's the approach to these facts that can be creative" (Elisabeth, Int. 2).

Thus, besides emphasising the applicability of creativity to different curricular areas, teachers in the study could also clearly establish a relationship between creativity and the subject they taught viewing the former as an inherent element of their discipline.

Creativity is different across curricular areas: problem-solving, self-expression, way of thinking

Most teachers in this study argued that different curricular areas required different forms of creativity. Domain-specific views on creativity were expressed by Rose as follows: "I believe that each area has its own type of creativity. And the areas in which people are creative vary considerably, depending on the person's interests and skills" (Rose, Int. 2). Another teacher argued that in maths "creativity is not the same as in arts or anywhere else" (Bill, Int. 2).

Moreover, teachers in the study also offered domain-specific conceptualizations of creativity. In visual and language arts, creativity was viewed as a form of artistic self-expression evident in creating or interpreting artistic products, a view shared by all four teachers of these subjects as illustrated below. Zoey, the visual arts teachers, for example, explained:

> Creative students in visual arts are capable of placing themselves in the artwork, either through the technique they use, or through their way of thinking, or their aesthetics. For me, this is creativity in arts, when something extra emerges, namely the students' own thoughts and not just what we learn or discuss together in the class. (Zoey, Int. 2)

Martha, the language arts teacher, also argued that creativity manifested as a form of self-expression in her subject:

> This is why creativity is so important [in language arts], because art comes closer to students only when they feel that it's not an entirely separate world which they will never have access to, but rather when we can find ways for them to feel that they also have something to express. In this sense, self-expression is often a way of self-knowledge, an inner process, that everyone should experience regardless of what jobs they will have in the future. (Martha, Int. 2)

In social studies teachers emphasised the problem-solving aspect of creativity, namely the identification of interesting and important problems, creative approaches to

gathering and analysing data, and offering original and useful interpretations of events. Boris, for example, argued that creativity in history could manifest in historical research, namely "creativity can be seen in the extent to which the tools used in research are traditional or new, or what the topic of the investigation is" (Boris, Int. 2).

EFL teachers viewed creativity in foreign languages as a way of original self-expression which was also appropriate to the situation, and dependent on one's language skills. Anita, in this respect, explained that:

> Creativity in language means that I can express myself in different ways, or I express myself in unusual ways. Not because I can't speak English, but because I can connect words and phrases in completely new ways, or use metaphors, or my individual language register to communicate something […]. I have something to say, then there are these elements of the language, and creativity appears in how I connect them. (Anita, Int. 2)

Mathematical creativity was seen as connected to thinking in original and flexible ways to solve mathematical problems evident, for example, in Rose's view who argued that in mathematics creativity manifested mainly "in developing logical skills, and allowing students to make and find connections" (Rose, Int. 2). Science teachers linked creativity with problem-solving, and saw it as related to the scientific method, as illustrated by Ada: "Experimenting is all about creativity" (Int. 2).

Thus, teachers in the study besides establishing a relationship between their own subject and creativity, also expressed subject-specific views of the concept.

Multiple creativities within one curricular area

In addition to conceptualizing creativity in their own curricular areas, several teachers highlighted that creativity from other domains may also manifest in their curricular area. Ada, in this respect explained:

> A solution to a science problem may be creative […]. Creativity, then can be the design of an object, or model […]. Projects also have end-products, the creation of which require a form of creativity not connected strictly to the subject. For example, creating a movie, a poster, writing an article, is not a usual form of assessment in physics, and these tasks may require another form of creativity by which those students who are not so good at physics may find themselves in the centre of attention. (Ada, Int. 2)

Other teachers (Albert, Boris, Martha, Susan, Robert) also indicated that the opportunities for students to express their visual and verbal creativity in their classes may offer a feeling of success for those more creative in other domains.

Hence, several teachers in this study held advanced views of creativity, recognizing, that curricular areas may accommodate creativity from different domains.

Creativity varies across education stages: less, different, and higher level creativity in secondary school

Ten teachers in the study shared the view that creativity decreased across the stages of education citing various reasons. Some teachers, for example viewed creativity as naturally present in smaller children, whose creative abilities, however, were seen to be gradually suppressed as they progressed through the education levels. In this respect, both Ada and Albert argued that as children grew less educational opportunities were provided for them to be creative. Anita also commented that the education system did not support students' creative growth due to its emphasis on convergent thinking practices:

> It's characteristic for the Hungarian education system that early on we crush kids' attempts of trying to find different answers, and get them used to giving one correct answer, and if they don't find that single one answer, they are wrong and get a C on the test. (Anita, Int. 2).

In addition, some participants argued that creativity was rarely emphasised in secondary education, the main goal of which was seen by many Hungarian teachers in preparing students for the exams (Bill, Elisabeth, Robert). These participants also argued that students, and especially those in the senior years, preferred not to be creative. Robert, for example, explained that "Kids at our school have expectations, they want to acquire the knowledge they need for college admission, and they do not need creativity for this" (Int. 2).

Some teachers also reported a decline in certain personal characteristics necessary for creativity across the education levels. Secondary students were believed to be less curious (Albert), less imaginative (Judith), less tolerant for ambiguity (Ada), and less risk-taking (Ada, Anita) than primary students. Ada for example explained the difference between creativity in primary and secondary school as follows:

> Secondary students will often ask themselves whether we have studied what is required to solve the problem, and if not, they will perceive this as an obstacle. 'How should I know this?' Younger students don't have that much knowledge,

> and aren't so much concerned with finding the right compartment of their brains to provide the answer or think about what they have learned about the topic, but rather focus on solving the problem itself, five or six graders, for example. Also, these younger kids can articulate how they wish to approach the task, but they don't have the means to solve it, so they ask for help. (Ada, Int. 2)

In contrast Judith believed that students' creativity did not decline with age but was rather transforming. She argued that secondary students could be losing their capacities for unconstrained fantasy, but might become more capable of finding original answers to problems using their knowledge and skills. Martha also expressed the view that secondary school students were capable of higher level creativity due to the progression of their knowledge in the subject area.

Overall, digital pedagogy expert teachers in this study believed that secondary students showed less creativity than primary students, which they explained with fewer creative opportunities in the secondary classroom, students' changing attitudes, and changing creativity-related characteristics.

Malleability

Two themes emerged regarding teachers' beliefs about the malleability of creativity. Data analysis indicated that teachers believed that creativity could be taught to a certain extent, but many of them thought that it was difficult to measure. The following Table 14 offers an overview of teachers' beliefs about the malleability of creativity along with the number of respondents and comments for each emerging theme.

Table 14. An overview of teachers' beliefs about the malleability of creativity in Study 2

Theme	Nr. of respondents	Total comments
Creativity can be nurtured to some extent	12	13
Creativity is difficult to assess	6	10
Totals	**18**	**23**

Creativity can be nurtured in every student to a certain extent

All teachers shared the common belief that creativity can be nurtured in every student. At the same time, several participants argued that the extent to which creativity develops depends on students' existing creative abilities, personal interests, and expectations.

For example, some teachers (Anita, Boris, Martha, Susan) emphasized that the individual differences between students in terms of creativity might determine the extent to which they could become more creative, as illustrated by Susan's words:

> I think creativity can be nurtured. Students come with a certain amount of creativity, whether this is 10% or 80%, I don't know [*laughing*]. I think that creativity can be fostered to a certain extent, if somebody is willing to or more prone to be creative, it can be fostered to greater extent, if not, then to a lesser one. (Susan, Int. 2)

Other teachers highlighted that students had different abilities and interests, therefore they could be creative in a particular domain, but non-creative in others (Rose, Bill, Ada, Robert). These teachers also emphasized the role they have in identifying and nurturing students' creativity. For example, Rose commented "What I find important, is to discover which student is creative in which area, so that we [teachers] can identify and support them. Not necessarily in all subjects, or only in math, but in any school subject" (Rose, Int. 2).

Thus, teachers in the study generally believed that creativity can be fostered across the secondary curriculum, also emphasising that higher levels of creativity could be achieved by those who have the necessary dispositions as well as domain-specific knowledge, skills, and talents.

Creativity is difficult to assess

Findings indicated that teachers' beliefs about the assessment of creativity differed considerably. While half of the teachers argued that creativity can and should be assessed, others (Anita, Boris, Bill, Judith, Martha, Susan) believed that the assessment of creativity is problematic, citing various reasons for their views.

First, creativity was believed to be difficult to assess due to the lack of right instruments to measure the construct. Judith, for example, felt insecure about assessing students' creative development in her classes, arguing that she could only rely on her own observations in determining whether students' creativity had increased, which, however, might not always be correct. Others highlighted that the difficulty of creativity assessment resided in the fact that any inappropriate feedback given to students might discourage their future creative efforts. Susan, for example, argued that assessing students' creativity "is extremely difficult […] The student was there, was working hard, had created something, then how could I say that this not good" (Susan, Int. 2). In addition, one

teacher argued that given the pitfalls of inappropriate assessment practices, creativity should be appreciated and encouraged, but not assessed in the classroom: "Creativity should be encouraged and highly appreciated. But if someone takes the risk and comes up with an idea, and I tell that person, that the idea is bad, then they will never share again" (Anita, Int. 2).

Finally, one teacher held the view that creativity measurement and assessment is detrimental for creativity.

> Creativity should be appreciated. If somebody comes up with an original solution, that should be appreciated. As far as measurement is concerned, I think creativity cannot be measured, because once we try that, we kill creativity. Every standardized measurement and assessment is against creativity, since if I want to examine problem-solving against the standards, I would render the creative forms of solving a problem impossible, because these cannot be measured per se. (Bill, Int. 2)

In contrast, there were six teachers (Ada, Albert, Robert, Rose, Elisabeth, Zoey) who argued that creativity should and could be assessed in the classroom. These teachers proposed various forms of teacher, peer, and self-assessment to evaluate students' creative products, as well as some forms of authentic assessment through technology detailed later in this section.

Overall, teachers expressed different views regarding the assessment of creativity which was often seen problematic due to (1) lack of knowledge about how to assess creativity, (2) the perceived threats posed by inappropriate assessment, or (3) simply because it was thought that the construct did not lend itself to any type of assessment or measurement. In addition to views about creativity, views about educational assessment and measurement also seemed influential with regards to participants' creativity assessment beliefs.

5.3.2 Teachers' beliefs about fostering creativity with technology (Interviews)

Digital pedagogy expert teachers' pedagogical beliefs revealed six themes with regard to technology-supported creativity fostering across the secondary curriculum. These themes included: igniting creative thinking through technology, developing and exploring ideas with technology, creating with technology, scaffolding students'

creativity with technology, augmenting creative collaboration with technology, and communicating and evaluating creative outcomes with technology. For a thematic map of teachers' pedagogical beliefs of nurturing creativity with technology see *Figure 14.* For of a complete coding analysis of the interview transcripts with reference to teachers' beliefs about nurturing creativity with technology including the frequency of responses for each theme see Appendix H.

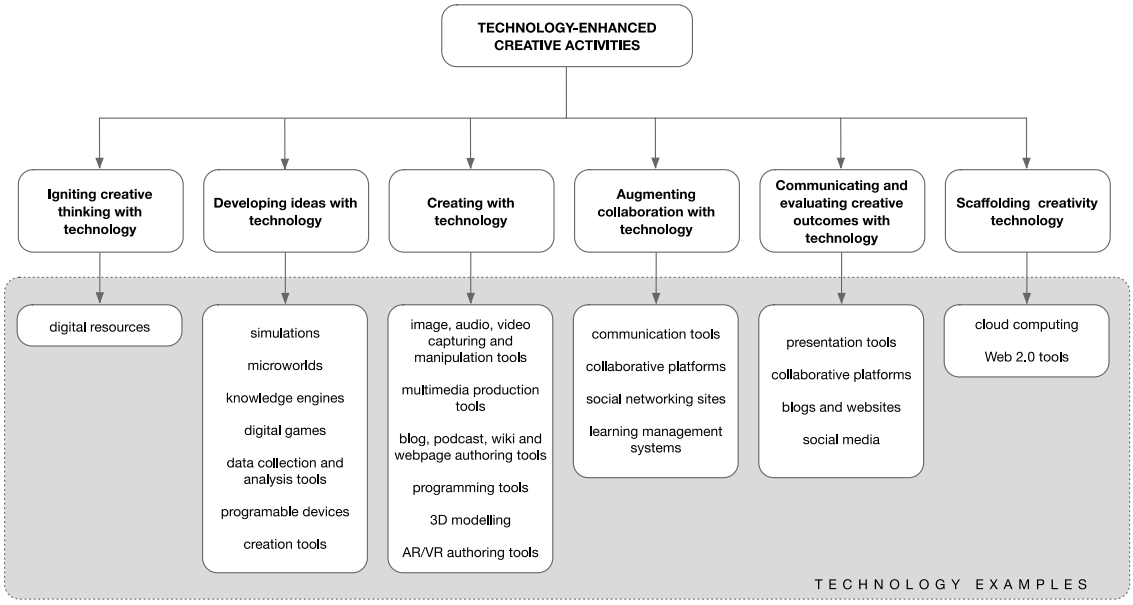


Figure 14. Digital pedagogy expert teachers' pedagogical beliefs of nurturing creativity with technology in Study 2

Igniting creative thinking through technology

Several digital pedagogy expert teachers (8) in Study 2 explained how digital resources were used in the classroom to spark students' interest and engage them in creative activities across curriculum. The value of such resources was emphasised, for example, by Anita who believed that online images, audio, and video resources as well as digital materials created by students themselves could provide valuable stimuli for creative language production in the EFL class. With respect to the benefits of student-created images as language production prompts she commented:

> I don't want to say that anything [any resource] can be creative, and that it's all the same if I bring in some pictures from a magazine, or if kids take photos with their phones, because it isn't, because it's great that they themselves take the photos, which gives them a sense of ownership, that this is my photo, I chose it, there was freedom involved. (Anita, Int. 2)

Online materials related to subject content were reported to provide a starting point for discussions about science phenomena (Ada, Albert), historical events (Boris, Elisabeth), or mathematical problems (Rose). Art teachers emphasised that artwork featured online could serve as a source of inspiration for students' own creative expression (Robert, Zoey). Two teachers (Zoey, Rose) noted, however, that the ease with which one could find information on the Internet made it tempting for students to copy rather than develop their own thoughts and ideas. The following Table 15 contains examples teachers provided for using digital resources to engage students in creative thinking across the curriculum.

Table 15. Teachers' examples of activities using digital resources to ignite students' creative thinking across the curriculum in Study 2

Subject area	Activities using digital resources to engage students in creative thinking	Digital resources used
ART	Teacher shows digital art resources to inspire students' creative expression.	online resources
	Students search for resources online as inspiration for artistic self-expression	
EFL	Teacher selects and gives students online digital images, sounds, videos as prompts for creative language production (oral or written).	online resources
	Students select and use online digital images, sounds, videos as prompts for creative language production (oral or written).	teacher-created digital resources
	Student create images, sounds, videos to be used as prompts for creative language production (oral and written).	student-created digital resources
HUN	Teacher creates and uses digital quizzes as a starting point for discussions in the classroom.	teacher-created digital resources
MAT	Teacher creates and uses digital quizzes as a starting point for discussions to prompt original and flexible ways of solving mathematical problems	teacher-created digital resources
	Teacher selects and shows videos about mathematical problems as a starting point for classroom discussions.	online resources
SCI	Teacher selects and shows videos to students about scientific phenomena as a starting point for discussions in the classroom.	online resources
	Students analyse teacher-created photos and videos created to develop understanding about phenomena during inquires	teacher-created digital resources
SOC	Teacher uses digital quizzes on historical events as a starting point for discussions.	online resources
	Teacher shares videos on historical events along with open-ended tasks to be discussed online.	
	Teacher shares videos on historical events into which she inserts open-ended tasks for students working individually or in groups.	teacher-created digital resources

Finally, it was also noted that online or teacher created quizzes might contribute to creative thinking in the classroom, specifically when questions contained in them had

more than one correct answer (Anita, Martha), or when used as starting points for further discussions (Bill, Boris, Martha).

As Table 15 and Appendix I show the activities discussed by teachers were mainly associated with two instructional strategies: lecture and dialogues (whole class, group, dyad). In fewer cases digital resources were used to ignite creative thinking in more complex learning strategies, such as project-based, inquiry-based or design-based learning. In terms of agency, electronic resources were either selected or created by the teachers, or the students themselves.

Developing ideas with technology

Several teachers in the study reported that they promoted students' creativity by designing and implementing technology-enabled activities that supported imaginative conjecture, exploration, and the representation of ideas. Examples provided by teachers involved the use of digital games, simulations, and microworlds to develop and test ideas, the application of real data collection and analysis tools during student led exploratory activities, as well as the utilization of creation tools to try out ideas during fashioning activities.

Science teachers in the study, for example, explained how microworlds (*GeoGebra*), simulations (*PhET*, *Intellisense*, *Yenka*), and knowledge engines (*WolframAlpha*), helped them design activities during which students could explore specific phenomena, processes, or systems which would be difficult or impossible to explore without technology. Ada, for example, commented that:

> Then there are many simulations, which cannot substitute real-life experiments, because those are still better, but we cannot build a nuclear reactor in the classroom, or things connected to planets. I mean when experiments would be difficult to carry out in the classroom it is great to use simulations in which you can manipulate variables. At the same time this involves creativity, because it is up to the students which variables they are going to manipulate, or if they find the variables which show an extraordinary phenomenon. (Ada, Int. 2)

Similarly, the two maths teachers emphasized that student-led activities conducted in the mathematical microworld Geogebra and with the knowledge engine *WolframAlpha* enabled students to generate and test ideas during mathematical problem-solving.

The benefits of serious games available for history classes were vaguely mentioned by the two social science teachers, who also noted that integrating commercial video

games like *Assassins' Creed*, *Total War*, or *Civilization V* into the secondary history curriculum could promote students' subject knowledge and creative thinking, nevertheless considered their implementation complicated in school settings. The following Table 16 contains the examples teachers provided for activities supporting idea development and exploration with digital tools.

Table 16. Teachers' examples of creative activities supporting idea development and exploration across the curriculum in Study 2

Subject area	Activities supporting idea development and exploration with digital tool	Digital tools used
ART	Students use graphic design software to try out ideas during creating artistic products.	creation tools
HUN	Students and teacher use collaborative word processing tools to edit and revise student writing (*Google Docs*).	creation tools
MAT	Students use digital manipulatives and visualization tools to develop ideas to solve mathematical problems (*GeoGebra*).	microworlds
	Students use knowledge engine to develop ideas to solve mathematical problems (*WolframAlp*ha).	knowledge engines
SCI	Students take photos, record videos with mobile phones to develop understanding about phenomena during scientific inquiries and experiments.	data collection and analysis tools
	Students analyse images, videos, data with technology during scientific inquiries (*LabCamera*, *Excel*).	
	Students design data collection and collect data with mobile technology during scientific inquires.	
	Students use simulations to conduct experiments impossible or difficult to carry out in real-world settings (*Intellisense*, *Yenka*, *PhET*, *GeoGebra*).	simulations
	Students use programmable devices to test ideas during scientific inquiries (*micro:bit*, *Lego* robots).	programmable devices
	Students use a knowledge engine to develop ideas while solving scientific problems (*WolframAlpha*).	knowledge engines
SOC	Students play digital games to develop understanding of historical events.	digital games

In addition, technologies to collect, represent, and analyse data were also believed to be useful tools to promote scientific creative thinking during inquiries and experiments. Science teachers reported that student activities utilizing technology to capture image and video, mobile phones apps to collect other types of data, as well as real-time data collection and analysis tools (e.g. *micro:bit*, *LabCamera*) could provide opportunities for students to develop and explore ideas in the science classroom.

Finally, the use of creation tools to support idea generation and testing were reported by two teachers (Martha, Zoey). Zoey explained that technology could make the design of art products much easier by allowing students to try out several ideas in a cost and labour-effective way:

> The number of variations also becomes infinite. When I was in college and wanted to try out colour variations, I used to be painting for days. Now it's one click. What I had been doing for days manually, I can do now digitally in two minutes. The possibility to correct, to change, to revise is much more open. It can help students a lot. (Zoey, Int. 2)

Similarly, Martha explained how collaborative writing tools could assist students to test and revise their ideas when producing texts.

The analysis of instructional strategies applied in technology-enhanced activities which supported the development and exploration of ideas revealed that such activities were predominantly associated with inquiry and problem-based, and in some cases with practice-based learning, involving both independent and collaborative student work (see Appendix I).

Creating with technology

Eleven of the twelve teachers in the study argued that technology can be integrated into teaching and learning while fostering creativity by giving students opportunities to create digital products across the curriculum. Participants described several subject-specific activities by which they engaged students in building or expressing knowledge through the capture, manipulation, and transformation of media. Student-created digital products discussed by participants included digital images, audio, graphic organizers, videos and animations, multimedia presentations, blogs, wikis, podcasts, webpages, games, programming codes, 3D models, and AR/VR content. Table 17 provides an overview of the subject-specific digital creation activities reported by teachers along with the digital production tools used for such activities.

As Table 17 and Appendix I indicate the instructional strategies used in conjunction with digital creative production involved predominantly project work and project-based learning, as well as practice-, problem- and design-based learning with students working in groups, or in some cases individually.

Table 17. Teachers' examples of digital creative production activities across the curriculum in Study 2

Subject area	Digital creation across the curriculum	Digital creation tool used
ART	Students take photos and manipulate images to demonstrate visual art skills while expressing themselves. Students create digital drawings to gain experience in the use of the tool while expressing themselves.	Image
	Students create digital infographics as products of self-guided inquiries in art history while demonstrating visual art skills.	Graphic organizer
	Students create and edit films based on their own ideas using studied composition techniques.	Video, animation
	Students create digital posters to advertise their own work.	Multimedia presentation
	Students design and print 3D objects to demonstrate knowledge of studied artistic and functional design principles.	Digital 3D modelling, holograms, AR/VR
EFL	Students create and edit films role playing situations, dramatizing, or narrating stories using English. Students create animations, narrate the stories, or create subtitles in English (*PowToon*).	Video and animation
	Students create multimedia presentations about a topic in English and present to each other.	Multimedia presentation
	Students create digital language games and quizzes for peers (Hot Potatoes, *Kahoot!*, *Quizizz*).	Games and quizzes
	Students write English language blogs. Students create English language podcasts about current issues for an international audience.	Blog, podcast, webpage, wiki
HUN	Students create digital cartoons to express their own interpretation of texts. Students create and manipulate digital images to illustrate literary texts. Students create memes to express own ideas, reactions to literary texts, or to express characters' ideas, feelings.	Image
	Students create imaginary radio interviews with literary characters.	Audio
	Students create films playing the role of literary characters or authors studied. Students create videos to express feelings, ideas about literary texts using moving images, photos created by them, or found online. Students create short clips on exam topics using moving images, photos created by them, or found online.	Video, animation
	Students create digital multimedia books about a literary period or genre and share with each other. Student create interactive multimedia posters or presentations about an author, a literary period, or a language topic (*Glogster*), and present to each other. Student create digital portfolios of creative writing products which they share with teachers and others.	Multimedia presentation
	Students share creative writing in student blogs. Students feature their work on project webpage for larger audiences. Students run online literary magazine featuring their own poems, essays, book, film, and theatre reviews. Students run and contribute to online newspaper during media and communication project available for wider audiences.	Blog, podcast, webpage, wiki

Table 17. (*continued*)

Subject area	Digital creation across the curriculum	Digital creation tool used
MAT	Students create videos of mathematical problem solving to demonstrate original and flexible thinking.	Video, animation
	Students create multimedia presentation to demonstrate understanding of mathematical concepts and show them to each other.	Multimedia presentation
SCI	Students create multimedia timelines in history of science and speculate on future directions.	Graphic organizers
	Students create short clips of scientific experiments carried out by them. Students create documentaries on science phenomena using their own photos, moving images, or online resources. Students create clips on final exam topics in science using moving images, photos created by them, or resources found online.	Video, animation
	Students create interactive multimedia posters, presentations about scientific inquiries carried out by them (*Glogster*) and show these to each other. Students create interactive posters to demonstrate inquiry-based learning featuring student created artefacts, procedures, and present these to each other (*Glogster*)	Multimedia presentation
	Students create wikis about science topics for classroom use. Students create and run an online science magazine on a website during a project available for a wider audience. Students feature their work and learning on the project website available for wider audiences.	Blogs, podcasts, webpages, wikis
	Students design and print 3D models to solve science problems. Students create digital holograms to visualize scientific concepts.	Digital 3D models, holograms, AR/VR
	Students create mobile applications related to science (*AppInventor*).	Programming
SOC	Students create historical digital cartoons to illustrate historical problems.	Image
	Students create infographics about historic events and their consequences (*Piktochart*). Student create multimedia timelines of historical events featuring important dates, events, sources. Students create digital flowcharts or mind maps to represent possible decisions of historical figures, and consequences.	Graphic organizers
	Student create webpages featuring historical essays, games, and resources available for wider audiences. Students create *Facebook* profiles for historical figures and post from their perspective.	Blog, podcast, webpage, wiki
	Students create history quizzes and games for peers (*LearningApps*, *Kahoot!*).	Games and quizzes
	Students create mixed reality historical exhibition using VR/AR in school.	Digital 3D modelling, hologram, AR/VR

Data analysis also revealed that several digital production activities teachers indicated to foster creativity were aimed at building knowledge and developing subject-specific creativity (e.g. building 3D models in science, or contributing to an online literary magazine). Other activities, such as creating multimedia presentations to demonstrate

understanding of a topic or to showcase project work, allowed students to express their learning in creative ways as well as their creativity in the area of digital communication.

Scaffolding creativity with technology

Ten of the twelve teachers in the study discussed how electronic environments and digital communication tools supported the facilitation and orchestration of student creativity and creative thinking in the classroom and beyond it. The technologies used by participants for such activities included communication tools such as email and *Skype*, social networking tools such as *Facebook* groups, collaborative platforms such as *OneNote* class notebook and *Google Drive*, and learning management systems (LMS) such as *NEO LMS* and *Spiral*. The following Table 18 provides an overview of the ways teachers in the study reported to scaffold creativity in the classroom through technology.

Table 18. Ways of scaffolding student creativity with technology reported by teachers in Study 2

Scaffolding student creativity with technology	Digital tools used
Teachers share online open-ended tasks as homework with students.	collaborative platform (*Google Drive*); LMS (*NEO, Spiral*); social networking site (*Facebook* group)
Teachers provide personalized feedback to students' ideas and creative work online.	LMS (*NEO, Spiral*); social networking site (*Facebook* group)
Teachers provide support to students engaged in creative work through online communication and collaboration	communication tools (email, *Skype*); social networking site (*Facebook* group); collaborative platform (*Google Drive, OneNote*); LMS (*NEO, Spiral*)

Some teachers discussed the potential of technology to engage students in creative thinking outside the classroom through sharing with them interesting resources and open-ended tasks online, and providing personalized feedback to students' ideas and creative outcomes (Albert, Bill, Boris). Bill, for example, explained how technology enabled him to provide instant feedback to his students, thus supporting their creative thinking processes:

> I like *Spiral* [a one-to-one learning platform], because I can ask open-ended questions, and students can send in drawings, and I can give immediate feedback to them. I can say, this part was good, or send it back to the student […]. I receive student answers one by one, and then I can go to the students and tell them, this is almost the right answer, how did you get there, let's see. And then students describe their way of thinking, so technology is very good for this. (Bill, Int. 2)

Others explained how they supported students engaged in creative work by mentoring students online, and/or facilitating communication and collaboration among them (Ada, Anita, Elisabeth, Judith, Robert, Rose, Susan, Zoey). Activities mentioned by teachers ranged from answering student questions through email, *Skype*, or in *Facebook* groups, to scaffolding and monitoring project work in collaborative platforms, such as *OneNote* class notebook (Ada, Elisabeth).

As Table 18 and Appendix I show, teachers believed that the electronic scaffolding of creative thinking and work could be used with various strategies: discussions, group work, and other more-complex learner-centred activities.

Augmenting creative collaboration with technology

While teachers considered collaboration as an important aspect of promoting creativity in the classroom reporting that their students often worked in pairs or groups during creative tasks, the role of technology in student collaboration was vaguely addressed during the interviews.

The seven teachers who discussed technology-enhanced collaboration in the creative process emphasised how digital tools facilitated co-creation in electronic environments. Students were reported to have worked on shared documents (Ada, Elisabeth, Martha, Susan), blogs (Anita, Judith, Martha), wikis (Ada), webpages (Ada, Elisabeth, Martha, Zoey), which allowed them to generate, create, and evaluate ongoing and final work in groups, and could also extend the creative process beyond the classroom. For example, Martha explained:

> It's great to work online, in let's say a shared *Google* document. You can take notes, edit, write, and the tool is capable of a lot of other things. It's not like emailing back and forth, which has a lot disadvantages over shared documents, but a way of genuinely working together. And it is creative because you have access to others' thought processes. (Martha, Int. 2)

While technology may enable students to work in diversified groups with collaborators beyond their own school, only one teacher in study reported that her students sometimes worked on creative activities with students from other countries, also adding that such projects demanded too much time both from teachers and students, and were therefore rare in her class. The following Table 19 provides an overview of the ways teachers reported to promote creativity through technology-enhanced collaboration.

Table 19. Technology-enhanced creative collaboration examples provided by teachers in Study 2

Technology-enhanced creative collaboration activities	Digital tools used
co-creation of digital products in electronic environments with classmates	shared documents (*Google Docs*), blogs, wikis, webpages
international collaboration in creative tasks	x

Data analysis also revealed that technology-enhanced collaboration was predominantly valued in group projects and project-based learning (see Appendix I).

Communicating and evaluating creative outcomes with technology

Nine teachers in the study discussed explicitly that creative student outcomes created were presented, published, or communicated through the use of technology in their classes, though the purpose, audience, and tools involved differed considerably (see Table 20).

Table 20. The purposes, audiences, and tools involved in communicate and evaluating student outcomes identified in Study 2

Audience	Purpose	Digital tools used
peers, wider audience teachers, peers specific audience	to showcase creativity to get teacher and peer feedback to get real world feedback	presentation tools, collaborative platforms, LMSs, Web 2.0 tools, social media

Some teachers reported that electronic presentations, document sharing, social media, and web 2.0 tools enabled students to share creative outcomes with each other or present them in the classroom to showcase and celebrate creative achievements (Anita, Zoey, Judith). Student-created products were also often made available for a wider audience on project websites created and managed either by the teacher or the students themselves (Elisabeth, Judith, Martha, Zoey, Judith). Some participants linked sharing and presenting student work within the group to peer and self-evaluation carried out through product evaluation rubrics (Ada, Martha, Zoey). Also, students were often asked to create certain products, such as quizzes, games, or other learning materials for each other, which was argued to give more relevance to their work (Elisabeth, Judith, Susan).

Furthermore, five teachers reported that students' creative products were created for and shared with specific audiences outside the classroom, making the realistic assessment of creativity possible. Examples in this respect included publishing English language podcasts on current Hungarian issues for a global audience (Anita), sharing

student art on *Facebook*, *Instagram*, and *Youtube* (Robert), entering various literary competitions with short videos and illustrations as well as running an online school magazine (Judith). Robert, for example, referred to how realistic assessment worked in the art class as follows:

> We sometimes upload creative products to YouTube where a lot of people can see it and we can see the likes, too. We even won competition based on the votes […] Artists nowadays need to have an online presence. (Robert, Int. 2)

One teacher noted that sharing student products online should be treated with caution: "I might be overcautious, but I am very careful about who shares what even if we are in a closed *Facebook* group", emphasizing that students should always be aware that their work would later be shared with others.

5.3.3 Perceived barriers and enablers to fostering creativity with technology (Interviews)

Findings in the previous sections revealed technology expert teachers' pedagogical beliefs about fostering creativity through digital tools across the secondary curriculum. This section focuses on the third research question of Study 2, namely **Q3:** What barriers and enablers do digital pedagogy expert teachers perceive to fostering creativity with technology in the context of the secondary education? Data analysis demonstrated that participants perceived several barriers and few enablers to technology-supported creativity-enhancement in the classroom. For a thematic map of the perceived barriers and enablers see *Figure 15*. For of a complete coding analysis of the interview transcripts with reference to the perceived barriers and enablers to fostering creativity with technology including the frequency of responses for each theme and subtheme see Appendix J.

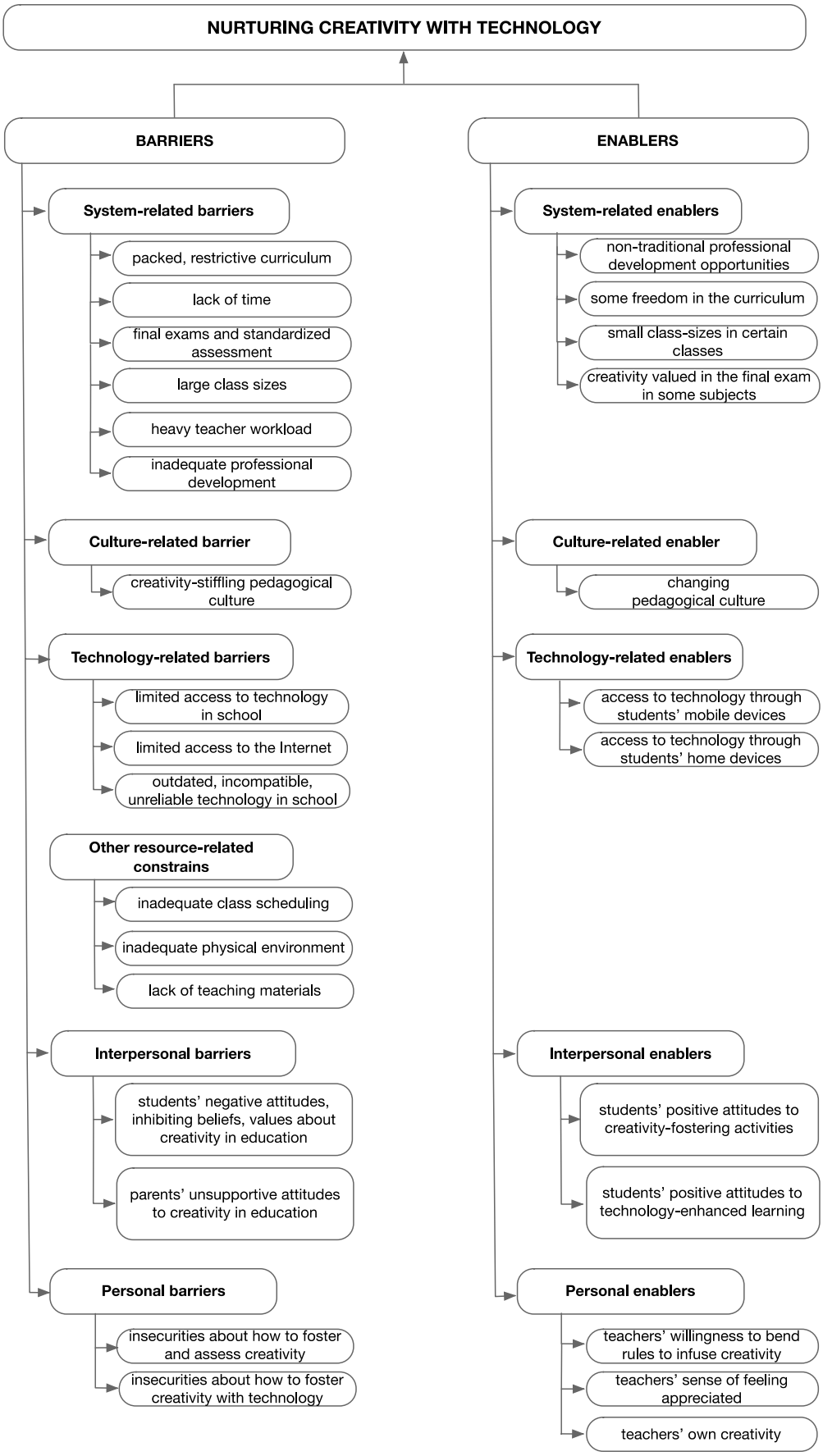


Figure 15. Perceived barriers and enablers to fostering creativity with technology in Study 2

Barriers to fostering creativity with technology in the classroom

Technology-integration expert teachers discussed a range of factors that might intervene in translating their beliefs and intentions into technology-enhanced creativity-fostering classroom practices. Analysis indicated that the constrains discussed by teachers can be categorized into five major themes: education system-related, culture-related, technology-related, other resource-related, interpersonal, and internal barriers. The following Table 21 provides an overview of the barriers along with the number of respondents and comments for each factor.

Table 21. An overview of the perceived barriers to fostering creativity with technology in Study 2

Barriers	**Themes**	**Nr. resp.**	**Nr. of comm.**
System-related	Curriculum: packed, restrictive	10	18
	Lack of time	9	22
	Final exam pressure and standardized assessment	7	12
	Large class sizes	5	8
	Heavy teacher workload	5	6
	Inadequate processional development courses	4	4
Culture-related	Creativity-stifling pedagogical culture	10	15
Technology-related	Access: Limited access to appropriate technology in school	9	18
	Connectivity: Bad or no Internet connection	5	6
	Usability: Outdated, incompatible, unreliable technology	7	12
Other resource-related	Inadequate resources (scheduling, physical environment, teaching materials)	6	7
Interpersonal	Students' attitude to creativity in education	8	17
	Parents' attitude to creativity in education	4	4
Personal	Teachers' insecurity about nurturing creativity with technology	3	3
	Teachers' insecurity about nurturing and assessing creativity	2	3
Totals		**94**	**155**

System-level barriers

System-level constrains refer to those associated with the educational system. Six constrains emerged from the data analysis as barriers to fostering the development of secondary students' creativity through technology: packed and restrictive curriculum, lack of time, final exam and assessment pressure, large class-sizes, heavy teacher workload, and inadequate professional development courses. Findings bellow illustrate the six constrains and the ways these mediate teachers' beliefs and practices.

- Packed, restrictive curricula:

With the exception of the two EFL teachers, all other ten participants perceived the curriculum to act as a serious constrain to fostering secondary students' creativity in their

own subject area. Ten educators felt that it was difficult to fit in creativity in their classes while covering the curriculum. Boris explained this idea by emphasizing how reducing curricular content would benefit creativity-fostering classroom practices:

> Creativity would be best supported, if the curriculum content was reduced, and this is true for all subjects. Creativity is best supported, when there is time to practice and get absorbed in a topic and explore. And it is all the same if this a trigonometric equation, or medieval history, or accountancy. (Boris, Int. 2)

Some teachers also referred to certain curricular restrictions which might prevent creativity to emerge in the classroom. Judith, for example, argued that though the official curriculum "does not prescribe the teaching methods one has to use, it does prescribe the knowledge and skills students have to acquire, and there are so many of these that it is impossible to teach them" (Judith, Int. 2).

It is also important to note that, though almost all teachers perceived the constrains presented by the curriculum, the extent to which they considered it as barrier differed considerably, which was most emphasized by Boris (social studies) during the interviews (5 mentions).

- Lack of time:

Lack of time was also considered a serious barrier to fostering creativity by ten secondary teachers in this study. Insufficient time was often perceived as an overlapping constrain with the content-packed curriculum, number of classes per week, and large class-sizes. Albert explained that in a class of 38 students, there was almost no time for student creativity to emerge (Int., 2). Zoey, raised the issue as follows: "I have to stress the lack of time [as barrier], and that one single class per week [of 45-minutes] does not support the development of creativity. I cannot address creativity very often in my classes, despite my effective lesson planning and management. You know, I also have content to cover" (Int. 2). Similarly, Bill argued:

> Three classes per week are not enough for much, and sometimes, we have to rush. But I have these specialized elective maths groups with six classes per week. In these classes, we can dedicate one hour per week to creative problem-solving, and to deal with interesting tasks. (Bill, Int. 2)

It is also interesting to note that the two EFL teachers, who did not view curriculum as a constraining factor in their own subject, also did not mention time as one, but discussed it with reference to other curricular areas.

- Final exam and standardized assessment pressure:

Related to curricular content and time, the final exam and standardized assessment practices were indicated by seven teachers as hindering secondary students' creative development through technology.

Four participants asserted that the pressure of final exams was detrimental to student creativity. Boris, for example, felt caught up between teaching for the final exam and fostering students' creativity in history, and explained that creativity fostering under such circumstances was almost impossible. Elisabeth, the other social studies teacher also argued that the last two years of instruction in secondary school was mainly focused on "training for the exam", which allowed less time for creative activities in the classroom (Int. 2). In addition, both teachers criticized the final exam material in history for its emphasis on the reproduction of factual knowledge.

The final exam was also perceived by the two mathematics teachers as a hindering factor. Bill, for example, argued that creativity in maths was not valued in the final exam, and therefore could not be properly valued in the classroom either:

> Because a student, who is creative, might be absent-minded and miscalculate something, and I cannot grade them with a five [equivalent to an A], because I know that the they will get a three or four [equivalent for B or C] on the final exam, and they are great and super talented, with lots of good ideas, but I cannot reward their creativity, because results are important, outcomes, and the final exam. (Bill, Int. 2)

Three other teachers (Anita, Robert, Zoey) highlighted that that the final exam constrained students' creative development referring to other subject areas but not to their own (arts and EFL).

Finally, two teachers (Ada and Bill) observed the negative role standardized assessment and grades could play in stimulating students' creativity. Since creativity could not be valued through grades, it had lost its relevance for todays' performance oriented education, they argued.

- Large class sizes:

Five teachers shared the view that it was difficult to nurture creativity in large classes. According to Albert, for example, creativity could not emerge in classes with 38 students and with teachers having 26 classes per week, because fostering students' creative capacities required differentiated and personalized approaches:

> It is very difficult, because creativity also requires individual treatment, and this does not refer to special need or exceptionally talented students, it just means that the teacher should be able to address students' personal questions and needs. If you have 38 students in the class, you cannot be expected to support all students' creativity in 45 minutes. (Albert, Int. 2)

- Heavy teacher workload:

Related to packed curriculum, lack of time, and large class sizes, final exam pressure, teachers' workload was also mentioned as constraining factor to fostering creativity by five teachers in the study (Albert, Boris, Elisabeth, Martha, Zoey). Participants argued that planning and managing creativity fostering activities required time and effort from teachers, which was especially true for technology-integrated project- and inquiry-based learning. In this respect, Zoey explained that "if a teacher wants to implement project-based learning, that means a lot of extra time and effort […] planning, continuously monitoring student work, giving feedback whenever needed, orchestrating summative assessment, and managing the publication of student work" (Int. 2).

- Inadequate professional development courses:

Some teachers reported that the professional development available to them through training and workshops were inadequate (Albert, Judith, Robert, Zoey). Albert, for example, pointed out the general poor quality of training he had experienced, which he believed led to "an aversion to anything labelled as alternative or as modern pedagogy" in teachers (Int. 2). The inadequacy of available professional development on technology-enhanced teaching and learning was further stressed by Zoey, who argued that training should be designed and implemented by active practicing teachers "who could show what exactly is possible with technology in the classroom through hands-on activities" (Int. 2). Judith commented that she had so much bad experience with professional development courses in educational technology that she was "afraid of what comes next" (Int. 2). Instead of such courses, Judith argued that teachers would rather need appropriate digital

tools and opportunities to use them. Finally, Robert noted that though he took part in many educational technology courses, creativity was rarely in their focus.

Culture-related barriers

Only one culture-related barrier emerged from the data analysis, namely the creativity-stifling pedagogical culture in Hungarian schools.

- Creativity-stifling pedagogical culture:

Ten teachers in the study expressed concerns regarding the pedagogical culture in Hungary which was thought to be unfavourable for creativity-fostering, be it with or without technology. These participants argued that many Hungarian educators were stifling their students' creativity by employing only teacher-centred activities, avoiding interdisciplinary approaches, preferring complete control over students, emphasizing factual knowledge, and teaching mainly for the final exam.

In this respect, Zoey explained that creativity required openness, also commenting that "teachers need to understand, they do not have to do all the talking during the class, but rather leave students to inquire, to look around, to share and discuss, even their half-baked ideas" (Int. 2). Ada argued that one of the main barriers to fostering creativity in education was that it was simply not a goal for many educators:

> Fostering creativity is not a goal for many teachers. They just want to cover the curriculum and have students recite what they have memorized. Then, they want students to pass the final exams successfully, get good marks. I do not think teachers care much about their students being creative or not. (Ada, Int. 2)

Participants, nevertheless, believed that the existent pedagogical culture was strongly linked to system-level barriers, such as the packed and restrictive curricula, lack of time, large class-sizes, also stressing the fact that to create a pedagogical culture compatible with creativity-fostering practices many external barriers should be removed.

Technology-related barriers

Ten teachers in the study identified technology-related factors that could act as constrain when nurturing creativity with digital tools in the classroom. These factors were grouped in five categories: access, connectivity, and usability.

- Access: Limited or no access to computers in the classroom

Nine out of the twelve digital pedagogy expert teachers argued that students limited access to computers and laptops in the classroom represented a serious barrier to fostering creativity with technology. Ada, for example, explained:

> Another important barrier [in addition to the packed curriculum] is the lack of digital technology in the school, namely the lack of laptops that students could use during such work [inquiry based learning, project work]. You can rely on assigning tasks as homework, but face-face collaborative work is also necessary for creativity. (Ada, Int. 2)

Teachers also discussed that while certain creativity-relevant tasks could be performed with small handheld devices (e.g. student phones or tablets), others required laptops or computers with large display and keyboard, especially when the creation of complex digital products was involved (Ada, Albert, Judith, Robert, Rose, Zoey).

Another problem identified by half of the teachers (Boris, Judith, Martha, Rose, Robert, Susan) was that, in some schools, computers for students were available only in special labs, which made the planning for creativity-enhanced learning activities complicated. Susan, for example, noted that sometimes she had to 'beg for' access to the computer lab, while Robert shared, that sometimes his students used his personal computer when creating artwork since they did not have regular access to the powerful devices in the computer lab.

- Usability: Outdated, incompatible, unreliable technology

Seven teachers reported that technical issues caused by outdated, incompatible, or unreliable technology often occurred during creativity fostering activities in their classes (Ada, Albert, Elisabeth, Susan, Rose, Robert, Zoey). These technical problems rendered the implementation of creativity-fostering activities difficult or even impossible. Robert explained that his school was not ready to foster creativity with technology due to outdated equipment. Albert highlighted how teachers' and students' motivation to use technology might fade away due to unreliable technology in the classroom.

- Connectivity: Limited or no access to the Internet

Connectivity issues were reported by five teachers as factors that acted as barriers to technology-enhanced creativity fostering practices, which often required students to search and share information over the Internet (Ada, Albert, Martha, Susan, Zoey). Specifically, the fact that students could not connect to the school Wi-Fi through their

own devices was considered a constrain, since with the lack of appropriate technology available in schools, creativity fostering tasks often relied on students' own mobile phones or tablets. Martha discussed this problem as follows:

> It would help a lot if we had devices, tablets with keyboards, netbooks, working Wi-Fi connection, broadband Internet, so that anyone could connect, and passwords were not a secret. I myself don't know the Wi-Fi password, I give my phone to the system administrator, who types the password in, so I don't know it [she laughs]. This is, of course, because the Wi-Fi is down, if too many people connect to it, so I understand this to some extent, but such things count. (Martha, Int. 2)

Other resource-related barriers

In addition to the technology-related constrains, six teachers (Albert, Judith, Martha, Robert, Rose, Susan) identified the inadequacy of other resources and their arrangements as barriers. For example, Judith argued that having 45-minute classes did not allow her students to immerge in creative exploration or production, while Rose discussed how complicated it was to change rooms when she wanted to use the computer labs with her students. The physical environment of the rooms was also considered undesirable by two teachers. Rose and Martha explained how in many rooms student tables were arranged in straight lines and not movable, which did not facilitate group work required for many creative tasks[4]. Rose noted that it was difficult to implement creativity-fostering collaborative activities in the computer lab which had a fixed arrangement. In terms of teaching resources, it was Robert who argued that more teaching material on technology-enhanced creativity would be required.

Interpersonal barriers

Interpersonal barriers refer to the impact of individuals around the teacher, such as parents and students. Two themes emerged in this respect, namely students' and parents' attitudes to creativity in education.

- Students' attitudes to creativity in education: risk-avoidance, low creative self-efficacy, undervaluation of creativity

[4] Most teachers in the study did not have their own classrooms.

Many teachers (8) in the study found that while some students enjoyed creativity-fostering activities in the classroom, others were reluctant or not willing to participate in such tasks.

Several teachers reported that students were often afraid to take the risks associated with creativity, and therefore were reluctant to or did not participate in creative tasks. Boris, for example, commented that "many students here approach a creative task telling that 'I won't do it', 'I might be wrong', 'Lets' do this together'" (Int. 2). Susan also explained that some of her students were "afraid to voice out their creative ideas or show others what they have created" (Int. 2). Students' low creative self-efficacy beliefs were identified as a barrier by Rose, for example, who explained that her students often did not believe in their own creative capacities which, according to her, stemmed from former schooling experiences:

> Many of them [students] don't believe they are capable of creativity, because they were blocked down in their early education, or they had not been exposed to situations in which they were encouraged to be creative. And encouragement alone is not enough when you are 15-18 years old (Rose, Int. 2)

Students' prior schooling experiences were also argued to shape their beliefs about teaching and learning, which in turn affected their willingness to be creative in the classroom. Traditional and limited views of teaching and learning, in which the role of the teacher was to share knowledge and that of the student to follow instructions, were perceived as challenges by three teachers (Anita, Boris, Susan). Susan, for example, stated she sometimes encountered students expressing negative attitudes towards creative tasks with some of them of arguing that "if you come to school, you need to learn and the teacher has to tell you exactly what to learn" (Int. 2).

Some teachers also reported that students often lacked the motivation to be creative. Anita, Bill, and Martha, for example, believed that students did not appreciate creative tasks in the classroom, because the education system itself did not value creativity. Bill, for example, stated that since the system was outcome-oriented, students "do not want to be creative, they want to achieve, they want to score high" (Bill, Int. 2). The same teachers also argued that students' workload and lack of time also negatively contributed to their willingness to be creative in the context of secondary education.

- Parents' unsupportive attitudes to creativity in education: undervaluation of creative pedagogy

Four teachers in the study raised the issue that parents were often unsupportive of creativity in education. Parents' beliefs about learning, which they saw as limited to regurgitating textbook content, was mentioned as hindrance by Albert. Boris argued that many parents were focused merely on their children passing the final exams, which affected creative pedagogical practices in his classes. In addition, Zoey, the art teacher, believed that parents' attitude to her creative subject, did not encourage children to take work too seriously, which she perceived as a constrain. Finally, Rose believed that negative parental attitudes to creative student behaviour could also have a flow down effect to classroom events, since the children of parents with such attitudes were often afraid to ask questions or share their creative ideas.

Internal barriers

Finally, findings revealed that certain barriers were directly related to teachers: teachers' insecurity about nurturing and assessing creativity, and their insecurities about using technology to foster creativity.

- Teachers' insecurity about using technology to foster creativity

Insecurities about using technology to foster creativity where reported by three teachers in the study (Martha, Rose, Zoey). Rose, for example, commented that she would need to learn continuously about technology, since it was changing so rapidly. Similarly, Zoey argued that teachers would need to develop their technological pedagogical skills to be able to teach for creativity with technology, which they often lacked the time for. Martha commented that teachers needed to embrace their insecurities linked to fostering students' creativity with technology, and use their own creativity when faced with uncertainties:

> "With technology it's even more complicated because you need a certain amount of humbleness in the learning process. If it doesn't work, I will try again and again, so when you start teaching with new technology, you won't feel that you do great things, but rather experience failure, so this requires a lot of energy. And it also requires creativity from the teacher, that there is this tool, and I want to know how I can use it effectively."

- Teachers' insecurity about nurturing and assessing creativity

Personal insecurities about nurturing and assessing creativity were mentioned by two teachers in this study (Judith, Martha). Martha discussed her dilemmas about how to

find the right balance between freedom and control during creative work, and how to give creativity-related feedback to students.

> Then there is this difficulty that one can get confused about how to assess creative ideas. And I have some experience in that now, but in the past I found myself in situations, when I said, that the idea was good, and then something entirely different, of bad quality was created, and I was the one who encouraged it. You have to be at your senses as a teacher, especially with the freedom involved in creativity. (Martha, Int. 2)

Similarly, Judith found that the difficulty in assessing creativity may represent a barrier to fostering it in the classroom, since she sometimes could not judge whether her creativity-fostering practices were effective or not.

Perceived enablers of fostering creativity with technology in the classroom

While educational technology expert teachers in this study discussed a range of barriers that might intervene in translating their beliefs into creativity-fostering classroom practices, they mentioned only a few enablers. The enablers of nurturing creativity with technology in the secondary classroom emerging from the analysis thus included five major categories: system-related, culture-related, technology-related, interpersonal, and personal (teacher-related) enablers. The following Table 22 provides an overview of the enablers along with the number of respondents and comments for each factor.

Table 22. An overview of the perceived enablers to fostering creativity with technology in Study 2

Enablers	**Themes**	**Nr. resp.**	**Nr. of comm.**
System-related	Non-traditional PD: self-directed, collaborative, practice-based	6	15
	Some freedom in the curriculum	4	5
	Small class sizes in some contexts	3	3
	Creativity valued in the final exam	2	3
Culture-related	Changing pedagogical culture	3	3
Technology-related	Access: Students' mobile devices	10	18
	Access: Students' home devices	6	8
Interpersonal	Students' positive attitudes to technology-enhanced learning	7	9
	Students' positive attitudes to creative activities	6	9
Personal	Teachers' willingness to bend the rules	5	7
	Teachers' feeling of appreciation	3	3
	Teachers' own creativity	3	3
Totals		**58**	**86**

System-related enablers

Only few teachers in the study indicated education system-related factors that supported them in fostering students' creativity with digital tools across the secondary curriculum. Three enablers emerged from the data analysis: non-traditional professional development, a curriculum allowing for creativity in some areas and aspects, small class sizes in certain contexts, and creativity valued in the final exam in some subjects.

- Non-traditional professional development: self-directed, collaborative, practice-based

Though teachers highlighted the scarcity of adequate professional development courses in educational technology and creativity, six participants discussed how online resources, collaboration with other teachers, as well as opportunities to design and develop technology-enhanced creativity-fostering activities through national or local programs helped them encourage students' creativity with digital tools, which thus constituted the most widely cited system level-enabler of fostering creativity through technology in secondary education. For example, Judith stressed the role of peers and colleagues in developing creativity-fostering practices as follow:

> We can learn from each other. I, for example, have colleagues, who inspire me. For example, Martha. I sometimes envy what she does, and then I adapt it. An inspiring intellectual environment and other's ideas can help a lot. Then there are the ideas of those who write in Tanárblog[5], those are important for me as well (Judith, Int. 2).

Teaching resources (textbooks, teacher blog posts with teaching ideas, webinars, project plans), and especially those created or curated by practising teachers, were also considered facilitators of fostering creativity (Anita, Albert, Ada, Judith). Finally, two teachers (Ada and Judith) argued that opportunities to design and implement project-based learning activities encouraged at national or school level could promote creativity-fostering practices in the classroom. An example offered by both teachers was the Digital Thematic Week (DTW), an initiative supported by the Ministry of Human Capacities, which allows teachers to implement cross-curricular digital projects in collaboration with other teachers.

- Freedom in some areas and aspects of the curriculum

[5] Popular Hungarian language educational technology blog for K-12 teachers. Available at: http://tanarblog.hu/

Four teachers agreed that certain aspects of the curriculum supported teaching for creativity. The two EFL teachers emphasized that the subject curriculum offered them a lot of freedom by which they could introduce several creative activities in their classes. Anita argued that EFL teachers were "lucky" in terms of creativity development, because they could do anything "as long as it was in English" (Int., 2). Two other teachers (Judith and Rose) argued that the curriculum in their subject areas allowed some creativity, since it did not prescribe the teaching methods, nevertheless, contained too many requirements, which reduced the time to explore topics in creative and innovative ways.

- Small class-size in certain contexts

Three teachers (Albert, Anita, Robert) argued that working with smaller groups of students allowed them to focus on students' creative development. Albert discussed the advantages of small group instruction for creativity as follows:

> I am spoiled, because we have a bilingual class, and there are only 10 students in the final exam preparation class, and you can do a lot of creative stuff with them. You can pay attention to each kid, and it works, and it is very motivating. (Albert, Int. 2)

Anita explained that creativity in the EFL classroom was supported by small group sizes which were typical for foreign language classes. She believed that students' verbal creativity could only manifest in an environment which allowed enough time for each student to use the language.

- Creativity valued in the final exam in some subjects

Only two teachers commented that the final exams facilitated creativity development (Albert, Anita). These teachers argued that creativity was valued in the national final exams in their subjects (science and EFL). Albert nevertheless pointed it out that the final exam might require creativity from students, but the curriculum did not value, stress, or allow for its development.

Culture-related enabler

Pedagogical culture emerged also as an enabler to fostering creativity through technology in secondary school, and in particular the recent changes towards a more progressive pedagogical culture in Hungarian schools.

- Changes towards a more progressive pedagogical culture that supports creativity and the use of technology in education

Three teachers discussed that certain recent changes in the pedagogical culture were facilitating creativity-fostering practices with technology in secondary schools (Albert, Bill, Rose). Rose believed there was a shift towards technology-integration and student-centeredness in many teachers' practices: "the world has become more open, teachers see a lot of things, and tend to teach in a different way. They tend to accept teaching with technology, and collaborative work" (Int. 2). Bill also argued that more and more schools, and teachers were recognizing the value of creativity in education, nevertheless, emphasized that the constraining factors, and especially final exam pressure, and standardized assessment prevented them from translating their positive beliefs into creativity-fostering practices (Int. 2).

Technology-related enablers

The perceived technology-related enablers to fostering creativity across the secondary curriculum discussed by teachers were related to access to technology and could be organized into two categories: students' access to technology through their own mobile devices, and students' access to technology through their home devices.

- Access: Students' access to technology through their own mobile devices

Ten of the twelve participants reported that technology-enhanced creativity-fostering activities in the classroom often relied on student-owned mobile phones (Albert, Anita, Ada, Elisabeth, Judith, Martha, Rose, Robert, Susan, Zoey). Teachers in the study argued the mobile phones supported creativity-fostering activities by allowing students, for example, to develop ideas through simulation apps, record data for later analysis, take photos or make videos of processes to use in presentations, (Ada, Albert), create prompts to inspire language production or digital products in EFL (Anita, Susan), record videos and take photos to express personal ideas and thoughts in Hungarian (Judith, Martha), and search the Internet for inspiration and information required for creative production in any subject (Susan, Robert, Rose, Zoey). The value of the availability of student-mobile phones was highlighted, for example by Albert who discussed that in the latest project students "measured almost everything with mobile phones, which was a great experience for students, since they realized that they have a mobile physics lab in their pockets" (Int. 2), or by Anita, who commented that voice recording "opens up endless opportunities" in language teaching and creativity-fostering (Anita).

On the other hand, several teachers (Albert, Ada, Judith, Rose, Robert, Zoey) argued that mobile-devices could not substitute computers and laptops, especially when

the creation of more complex digital products was involved, and that the lack of or bad Internet connection often limited the use of such devices to foster creativity (Martha, Susan, Zoey). Another issue raised by teachers was that some schools restricted the use of student mobile devices, yet some teachers allowed students to utilize them to support creative work in their classes (Ada, Susan).

- Access: Students' home access to technology

Some teachers in the study discussed that due to the packed curriculum, lack of time, and lack of access to appropriate technology in school, certain creativity-relevant tasks, and especially creative production was often carried out by students at home (Ada, Albert, Robert, Rose, Susan, Judith). Rose, for example, pointed out that she relied on students' home devices when planning for creativity using technology (Rose, Int. 2). This view was also shared by Judith, who, nevertheless, emphasised that this situation was more a necessity than an optimal state, since such activities require extra effort both from students and teachers:

> But this means a lot of work, both for the students and the teacher, sometimes, yes, this can be a solution, but you can't do this on a regular basis. We can't take beyond the school what belongs to the school. (Judith, Int. 2)

Thus, while students' home access to technology acted as an enabler to fostering creativity with digital tools, it also seemed to represent a constrain due to the extra time and effort that needed to be invested in technology-enhanced creative tasks beyond the school.

Interpersonal enablers

Two themes emerged as interpersonal enablers: students' positive attitudes to technology-enhanced learning, and students' positive attitude toward creativity-fostering activities.

- Students' positive attitudes towards technology-enhanced learning

Seven participants (Anita, Boris, Elisabeth, Judith, Martha, Robert, Zoey) explained that students generally enjoyed working with appropriately chosen technology in the classroom. Anita, for example, explained that "sometimes students become more enthusiastic if they can use their phones" (Int. 2). A view shared by many teachers was that today's students need and prefer the use digital tools in the classroom, stressing at

the same time that technology "should be treated as a tool chosen carefully to learning aims and content" (Albert, Int. 2).

- Student positive attitudes towards creativity-fostering activities

It is interesting to note, that while several teachers indicated students' negative attitudes towards creativity-fostering tasks as a constrain, others reported that students' enjoyment related to such activities may lead to more creativity in the classroom (Ada, Boris, Judith, Martha, Robert, Rose). Ada, for example, argued that creativity-fostering activities motivate both students and teachers:

> There is a demand [for creative learning]. If the teacher already does such an activity with students, they will want to learn differently [from the traditional teacher-centred approach]. And its popularity among students, its effectiveness, if an educator has already implemented such activities, these will drive them to implement more. (Ada, Int. 2)

Similarly, Judith argued that learning by producing creative outcomes brings joy to students in her classes and increases engagement, which was why she believed they were worth promoting.

Personal enablers

Three themes emerged as enabling factors related to the teachers' themselves. These included teachers' willingness to bend rules to infuse creativity in their classes, teachers' sense of being appreciated, and teachers' own creativity.

- Teachers' willingness to bend rules to infuse creativity

Five teachers in the study discussed how they created opportunities for creativity in their classrooms by bending or breaking rules (Ada, Bill, Boris, Judith, Martha,). With respect to the packed curriculum, Bill commented that teachers could select what to teach based only on the requirements of the final exam thus making more time for creativity. As he argued, teachers "can close the door behind them and do what they want" as long as the students were successful on the exams. Ada explained that she often integrated student-led experiments and project-based learning into her classes by placing less emphasis on certain curricular content requirements:

> There is the syllabus and the curriculum, the teaching of which is quite fast-paced, and integrating an hour-long student experiment, or student-led inquiry, or project

> work is very time consuming, nevertheless extremely useful and effective, which you can implement, only if you focus a bit less on other areas. (Ada, Int. 2)

Ada also commented, how she made exceptions when applying school rules which restricted the use of mobile phones in the classroom, if she believed their use would facilitate learning and creativity.

- Teachers' sense of feeling appreciated

Three teachers in the study (Ada, Judith, Robert) pointed out that the appreciation of the efforts invested into fostering students' creativity through extra work could also be motivating. Robert, for example, commented as follows: "The truth is that positive feedback is a great pleasure. I think that if someone is constantly working on improving things and on personal development, and has results in doing that, that teacher must be recognized somehow" (Int. 2). Similarly, Judith highlighted the importance of recognizing those teachers who were willing to constantly innovate. These two teachers, thus, linked creativity-fostering practices with educational innovations.

- Teachers' own creativity

Though several teachers reported creative teaching practices throughout the interviews, there were three participants (Albert, Elisabeth, Robert) who discussed how teachers' own creativity was required to teach for creativity across the curriculum.

5.3.4 Expert teachers' enacted beliefs of nurturing creativity with technology (Interviews, observations, document analysis)

The importance of teachers' beliefs rests in their possible relationship with practice (Fives & Buehl, 2012). This section focuses on the fourth research question of Study 2, namely **Q4:** What characterizes Hungarian digital pedagogy expert teachers' enactment of their beliefs about nurturing creativity with technology in the classroom? The enactment of pedagogical beliefs about creativity have been investigated based on the interviews as well as the observations conducted in digital pedagogy expert educators' classes, while the analysis of documents the participants shared with the researcher, and the images of the learning environments captured after the observations were used to further cross-examine findings. The following Table 23. provides a description of the observed classes (Obs.). An overview of the documents analysed was provided in Table 11.

Table 23. Description of the observed classes in Study 2

Participants	Context	Environment (general and technological)	Summary
Anita (EFL1) 11 students	11th grade EFL Advanced elective course Topic: Speculating about people and places Duration: 45’	Regular classroom, horseshoe seating plan Students’ mobile phones (1 per student) Photo capturing tool Sound recording tool *Facebook* group Email	First, students learnt expressions to speculate about past events through personalized tasks, practiced using the new language in pairs. Students then, either individually or in pairs, took photos in the school with their mobile phones to use them as prompts for speculations. Each student shared his/her photo with another student, who then speculated about where the photo could have been taken. These monologues were recorded and sent back to the student who took the photo and the teacher for feedback. Students could choose the tools they wanted to use to share photos and voice recordings.
Susan (EFL2) 14 students	9th grade EFL Regular class Topic: Culture - English speaking countries (Review) Duration: 45’	Regular classroom, horseshoe seating plan Teacher laptop LCD projector Students’ mobile phones (1 per student) Kahoot!	Students in groups of three played *Kahoot!* trivia quizzes they created at home. Questions were based on what had been studied during the semester and on students’ self-directed Internet-based research findings. Quiz categories had been chosen by student groups. One student from each group presented and moderated the “quiz show” using the teachers’ laptop connected to the LCD projector available in the classroom, while others played and competed using one student mobile phone per group. Before each quiz students also shared handouts with information helpful to answer the questions in the quiz and which was based on their self-directed inquiry After playing each quiz students and teachers gave verbal feedback to quiz question quality and language accuracy. Students would continue to present more quizzes in the next class.
Martha (HUN1) 14 students	11th grade literature Advanced elective course Topic: Symbolist poems Duration: 90’	Part 1 Computer lab, horseshoe seating plan Teacher desktop computer LCD projector Student desktop computers (1 per group) *MS Movie Maker* Part 2 Regular classroom, traditional seating plan Common areas in the school, park nearby and streets Teacher laptop Student mobiles Photo, video, and sound capturing tools	During these two lessons students created poetry videos in small groups. Part 1 After introducing the task, the teacher played a model video to students, which was followed by a whole group discussion of what constitutes a quality poem video. Teacher also highlighted some features of the *MS Movie Maker* students could use in their video clips. Students then chose a Symbolist poem, planned their videos, left the classroom, and worked in common areas or outside the school to record sound, and moving images using their mobile phones. Part 2 Students returned to the classroom and played their audio and video recordings to the teacher. Some groups revised their work based on the feedback they received from the teacher. At the end of the class, the teacher saved students’ raw materials on her computer. The poem videos were edited during the next class in the computer lab.
Judith (HUN2) 13 students	11th grade Hungarian literature Regular class Topic: The Tragedy of Man (Hungarian play published in 1861) Duration: 90’	Computer lab, traditional seating plan Teacher computer LCD projector Student desktop computers (1 per student) *RealtimeBoard*, *LearningApps*, *Doodle* *Google Docs* and *Drive*	Part 1 Students accessed a *RealtimeBoard* with the tasks of the class and links to online sources through the desktop computers in the lab. Students first solved an exercise in *LearningApps* matching famous quotations from the play with major themes, which was then checked and discussed as a whole group. Student pairs were then asked to choose a theme and identify related problems using the online sources the teacher shared with them through *RealtimeBoard.* Problems were discussed as a whole class. Part 2 Students in pairs chose a scene from the play in *Doodle* and began to write collaboratively a synopsis and screenplay, setting the chosen scene in modern times using *Google Docs.* Students continued to work on their scenes the next time they had access to the computer lab.
Bill (MAT1) 10 students	11th grade maths Advanced elective course Topic: analytic geometry equations Duration: 45’	Regular classroom, traditional seating plan Teacher laptop, router LCD projector Students’ mobile phones Kahoot!, *GeoGebra*, *WolframAlpha*	Students in this class solved mathematical problems related to analytic geometry equations. Students played individually a teacher-created mathematical *Kahoot!* maths quiz using their own mobile phones. Students used *WolframAlpha* or *Geogebra* to find the right answers to quiz questions. Solutions were discussed as a whole group after each question. The quiz was moderated by the teacher, who also asked students several open-ended questions.

Table 23 (*continued*)

Participants	Context	Environment (general and technological)	Summary
Rose (MATH2) 13 students	9th grade maths Regular class Topic: inequalities (Review) Duration: 45’	Regular classroom, traditional seating plan Teacher desktop computer Interactive Whiteboard *PowerPoint* *Popplet* *CrosswordLabs*	In this review lesson students were first asked to brainstorm mathematical concepts learnt in connection with inequalities. Concepts were to be categorized using *Popplet* at the Interactive Whiteboard. This was not possible due to technical problems. The teacher then presented a *PowerPoint* containing optical illusions, and students were asked to recognize and discuss the type of inequalities represented by each image. Students then solved inequality problems. As homework students were asked to solve additional inequality problems. As an optional task, students could create a mindmap in *Popplet* or a crossword puzzle in *CrosswordLabs* of the reviewed concepts, and were asked to share these in their Maths *Facebook* group.
Ada (SCI1) 28 students	9th grade Regular class Project week Topic: motion (Review) Duration: 180’	Physics lab (group pods), hall, meeting room (group pods) Teacher desktop computer Student laptops (2 per group) Student mobiles *Lego* robots *Micro:bit* *OneNote* *Lego Mindstorms* *LabCamera*	In this day of the project week students solved problems and challenges using their knowledge in physics and mathematics in small groups. Each group had a OneNote shared notebook for planning and documenting group work. Students could choose from seven problems or challenges: 1. Build a functioning toy car using 3D printed elements. 2.Build the fastest solar power fuelled toy car. 3. Construct a parachute that will deliver an egg safely to the ground when dropped. 4. Organize a *Lego* robot race in the group and create a video of it. 5. Build a toy sailboat. 5. Build a paddleboat. Students used their mobile phones and *LabCamera* on their laptops to collect and analyse data and refined their ideas based on the findings. Also, students were asked to take photos, create videos and written explanations of their solutions to these tasks. Outcomes would be presented and evaluated by teachers and peers based on rubrics at the end of the project week.
Boris (SOC1) 29 students	9th grade history Regular class Topic: The Middle Ages (Review) Duration: 45’	Regular classroom, traditional seating plan Teacher laptop LCD projector *Plickers*	After discussing the homework, students played a teacher-created and moderated *Plickers* quiz individually. After each question, possible answers were discussed as a whole group. The teacher also asked several open-ended questions. At the end of the lesson, the teacher announced the winners of the quiz.
Elisabeth (SOC2) 25 students	8th grade history Regular class Topic: Introduction to Napoleonic Era Duration: 85’	Regular classroom, group pods Teacher laptop Interactive Whiteboard Student laptops (one-to-one) *OneNote* *PowerPoint* *LearningApps* *YouTube*	At the beginning of the class students presented the infographics they had created on the French Revolution, and received short verbal feedback to them from the teacher and peers. Students in pairs or groups solved two teacher-created interactive exercises in *LearningApps* which served as an introduction to the new topic. After a teacher-created *PowerPoint* presentation on Napoleon students were asked to watch a short documentary and answer related questions. Students worked on this task in groups in the classroom or in the hall. After a whole class discussion, students were asked to imagine what they would need to do to become the ruler of Europe if they were young Napoleon. Students used *OneNote* to take notes and did online research to do this task. Students would continue to work on this task the next class.
Robert (ART1) 33 students	10th grade art history Regular class Topic: Leonardo da Vinci Duration: 45’	Regular classroom, traditional seating plan Teacher laptop Interactive Whiteboard Students’ mobile phones QR reader	After recognizing paintings hidden behind *QR* codes and brainstorming about Leonardo da Vinci, in this lesson students took part in an interactive lecture. The teachers’ lecture was supported by a teacher-created *interactive whiteboard presentation* featuring da Vinci’s paintings as well as several pop cultural references to his work. During the presentation, the teacher asked several open-ended questions from students and students could also solve interactive tasks at the whiteboard. Students then interpreted paintings in pairs and discussed interpretations as whole class. At the end of the lesson students were asked to create a reinvention of one of da Vinci’s works as homework.
Zoey (ART2) 24 students	10th grade visual culture Regular class Topic: Renaissance, reinventions of masterpieces Duration: 45’	Art room, traditional seating plan Teacher laptop Interactive Whiteboard Students’ mobile phones *Kahoot!* *LearningApps* *Google Drive*	This class started with a teacher-created and moderated *Kahoot!* review quiz in which students competed individually using their own mobile phones. Teachers told students that they were going to create a reinvention of one of da Vinci’s masterpieces. The teacher shared with students the link to a *LearningApps* matching game through *Google Drive*. Students worked in groups and matched the reinventions with the original pieces using their mobile phones. The teacher shared 11 famous Mona Lisa reinventions with students who then discussed the artistic technique, period and style used in each. Students then did brainstorming about the reinventions they were going to create and searched the Internet on their mobile phones to develop ideas. Students could choose to create either a digital or an analogue image. The task was completed as homework.

Teachers' beliefs about the meaning of creativity and their classroom practice

Digital pedagogy expert teachers in Study 2 discussed a range of beliefs they held about creativity. The analysis of classroom observations and documents showed that teachers' practices were in general alignment with several beliefs they expressed in the interviews, while misalignment between educators' beliefs and the observed or inferred practices was found only in few cases.

Teachers' definitions of creativity and classroom practice

Teachers in this study agreed that creativity required both originality and task-appropriateness which view they expressed several times across the interviews. Many teachers also recognized that certain personal characteristics were necessary for creativity, such as curiosity, knowledge, hard work, risk-taking, and imagination. Several teachers were also found to be aware of how environmental conditions, such as idea time, safety and trust, balance between freedom and constrain, influence creativity, also recognizing their own responsibility of establishing such conditions. The observed lessons provided some insights to the alignment of these beliefs to classroom practices.

In terms of personal characteristics, observation data and document analysis showed that teachers cultivated creativity along with subject-specific knowledge. In all the observed lessons, students were required to use or build content knowledge and skills during the creative thinking and production activities, whereas the appropriateness of student ideas and outcomes were often discussed and evaluated (see Table 23).

In terms of the environmental conditions, observation data revealed some differences between teachers espoused beliefs and enacted classroom practice. While nine teachers argued that freedom is required for creativity, four of them (Boris, Bill, Robert, Rose) implemented modest student-centred activities in the classroom relying mainly on teacher presentation, questioning, and shorter periods of whole group discussions, or discussions in pairs (see Table 23). In two cases, creative tasks in which students had more freedom but required more time were assigned as homework (Rose, Obs.; Robert, Obs.), while in another case the analysis of the project documentation (Boris, Doc. 1.) revealed a predominance of student-centred pedagogical approaches, suggesting that contextual factors may mediate these teachers' beliefs.

In addition, classroom observation revealed that teachers managed to establish an environment characterized by safety and trust, in which students often expressed their

ideas in dialogues and showcased creativity (see Table 23), this may nevertheless not be true for all students, whose perceptions were not investigated in the present study.

Teachers' beliefs about the specificity of creativity and classroom practice

Interview findings showed that several teachers expressed the view that creativity was easier to find in the arts-related subjects, arguing nevertheless that creativity was relevant in all curricular areas. In addition, participants could clearly establish a relationship between creativity and the subjects they taught. In line with their expressed beliefs, the analysis of observation data and documents revealed no arts bias in teachers' classroom practices: creativity-promoting activities were not focused on artistic tasks in subjects not directly related to the arts. On the contrary, interdisciplinary approaches bringing together, for example, STEM and arts were scarce, and identified only in Rose's case whose students investigated symmetry in arts and maths during a project week (Doc. 2), and who also used artwork (optical illusions) as prompts to discuss inequalities in the class (Rose, Obs.).

In addition, observation and document analysis findings also highlighted general alignment between subject-specific conceptions of creativity and creativity-fostering practices in all cases (see Table 23):

- In visual arts both teachers viewed creativity as a form of artistic self-expression evident in interpreting and creating artistic products, while students in the classes observed were required to interpret artwork and create their own artistic products (Robert, Obs.; Zoey, Obs.).
- Hungarian language and literature teachers also conceptualized creativity as a form of self-expression exhibited in interpreting and creating literary products, or products related to other art forms as well as in communicating across different media. This conceptualization resonated well with teachers' practices observed in the lessons: students transposed scenes from a drama to present day contexts (Judith, Obs.) and created symbolist poetry videos (Martha, Obs.).
- Social studies teachers in the interviews emphasized the problem-solving aspect of creativity, more specifically the identification of interesting and important problems, creative approaches to gathering and analysing data, and offering original and useful interpretations of events. This conceptualization was evident in Elisabeth's observed class during which students gathered and analysed data

to find possible explanations for Napoleon's rise to power (Elisabeth, Obs.), while Boris' class was mainly focused on divergent interpretations of historical events (Boris, Obs.).

- Foreign language teachers defined creativity in their subject as a way of original self-expression appropriate to the situation and dependent on one's language skills, in line with the observed classroom activities which required creative communication in the target language (Anita, Obs.; Susan., Obs.).
- Mathematical creativity was connected to thinking in original and flexible ways to solve mathematical problems, which was the focus of Bill's and Rose's observed lessons (Bill., Obs.; Rose, Obs.).
- Finally, science teachers defined creativity as problem-solving and as related to the scientific method, which was in-line with the inquiry-based instruction observed in the classroom (Ada., Obs.) and the learning activities featured in Albert's document (Albert, Doc1).

Teachers in the interviews also expressed that more types of creativity could be promoted in the classes they taught. Examples of creativity-fostering practices in oral, written, and visual communication were highlighted across the interviews and documents analysed. For example, creating poetry videos in Martha's Hungarian language and literature class or infographics in Elisabeth's social studies lesson required students to use their creativity in the visual domain (Elisabeth, Obs., Marth., Obs.). The documentation of several projects showed that students often tapped into their verbal and visual creativity when communicating learning outcomes and the results of their inquires (Ada, Doc. 1, Doc. 2; Albert, Doc. 1; Boris, Doc 1.; Judith, Doc. 1; Rose, Doc. 1).

Teachers' beliefs about the malleability of creativity and their classroom practice

Digital pedagogy expert teachers in Study 2 expressed the belief that creativity can be nurtured in all students to a certain extent. Classroom observation and document analysis provided further support for this finding since teachers implemented creativity-fostering activities with every student in the lessons observed while project descriptions also referenced the participation of regular student-groups in creativity-fostering activities (see Table 23) Three lessons observed were part of advanced elective courses (Anita, Obs., Bill, Obs., Martha, Obs.) which, however, were explained by the higher

number of classes per week (Martha, Int. 2, Obs.; Bill, Int. 2), and the fact that the teacher taught in only such classes (Anita, Int. 2).

Interview findings showed that teachers beliefs about the assessment of creativity differed considerably with six participants arguing that creativity could and should be assessed. Others believed that the assessment of creativity in the classroom was problematic, impossible or even detrimental to students' creative development. The analysis of observation data and documents confirmed that the assessment of creativity was problematic for most teachers. In some classes, student products were shared with the teacher and peers to showcase creativity (Elisabeth, Obs.), and/or evaluated for quality and accuracy (Anita, Obs.; Susan, Obs.). Students also received general feedback while planning and creating digital products (Martha, Obs., Judith, Obs., Zoey, Obs.), and to their creative ideas while problem-solving (Bill, Obs., Ada, Obs.). Nevertheless, during the observed lessons creativity was not discussed or assessed per se.

Document analysis also showed that during projects teachers planned various forms of assessment for learning (Albert, Doc1.; Boris, Doc 1., Judith, Doc. 1, Rose, Doc. 1; Zoey, Doc. 1), yet the assessment of creativity was only referenced in one document (Ada, Doc 1.): Ada included creativity in the project rubric of the online science magazine articles her students were required to write based on the inquiries they had conducted.

Teachers' technology-enhanced creativity-fostering beliefs and their practice

The analysis of classroom observation and pedagogical documents revealed the same themes with regard to technology-enhanced creativity enhancement across the secondary curriculum identified in the interviews: igniting creativity with technology, developing ideas with technology, creating with technology, scaffolding creativity with technology, collaborating with technology. The following Table 24 provides an overview of the themes across interviews, observations, and documents along with the number of participants.

Table 24. An overview of technology-enhanced creative activities across data sources in Study 2

Themes	Number of participants		
	Interviews	*Observations*	*Documents*
Igniting creativity with technology	8	6	3
Developing ideas with technology	8	4	4
Creating with technology	11	9	8
Collaborating with technology	8	3	6
Scaffolding creativity with technology	10	3	5
Communicating and evaluating creativity with technology	9	4	3
Total number of participants	**12**	**11**	**10**

Igniting creativity with technology

In the interviews, several digital pedagogy expert teachers (8) argued that digital resources could be used in the classroom to ignite students' creativity and engage them in creative activities. This theme emerged from observation data as the most widely applied technology-enhanced creative activity implemented in six lessons (Obs., Anita; Obs., Bill; Obs., Boris; Obs., Robert; Obs., Rose; Obs., Zoey), and being the only method in three lessons (Boris, Obs.; Robert, Obs.; Rose, Obs.). Several participants across the observations used digital resources in conjunction with teacher-created presentations and discussions (whole class, pair, or group). For example, the two arts teachers showed several artworks to their students to provide inspiration for students' subsequent artistic production task (Robert, Int. 1, Obs.; Zoey, Int. 1, Obs.). Bill and Boris created quizzes in history and mathematics the questions of which were used as starting points for whole class discussions with students (Bill, Int. 1., Obs.; Boris, Int. 1., Obs.). An interesting use of technology to engage students in creative thinking was observed in Anita's EFL class, in which students created photo prompts for a subsequent creative language production task (Anita, Obs.). Anita argued that such technology-enhanced activities could give students ownership and thus motivate them to engage in creative tasks (Anita, Int. 2).

Igniting students' creativity through technology also emerged as a theme from document analysis which suggested that teachers used digital resources to inspire students' creativity and engage them in creative thinking during group-projects and project-based learning, too (Ada, Doc. 1, Doc. 2; Judith, Doc. 1, Doc. 2; Rose, Doc 1). Documents shared by Rose, for example, contained the description of activities in which puzzling videos were played to motivate students to engage in brainstorming and problem-solving related to environmental issues (Rose, Doc 1.), while Judith's students

watched a fake documentary before engaging in weeklong project on fake news (Judith, Doc. 1).

Developing ideas with technology

Digital pedagogy expert teachers in Study 2 argued that students' creativity could be promoted through technology-enabled activities that supported imaginative conjecture, exploration, and the representation of ideas. Creative activities in which students worked with technology to develop and explore ideas were observed in four lessons (Obs. Ada, Obs. Bill, Obs. Elisabeth, Obs. Judith, Obs. Zoey). During inquiry-based learning about motion in Physics, Ada's students used a variety of technology, such as programmable devices (*micro:bit*, *Lego* robots), data collection and analysis tools (mobile phones, *LabCamera*) to develop solutions, test ideas, build models, in pairs or groups. Judith's students could revise and refine their ideas while writing collaboratively in GoogleDocs the synopsis of the modern day reinterpretation of a drama studied as well as use online resources as input when needed to further develop their ideas. Bill's students could test their ideas while solving mathematical problems individually using the microworld *GeoGebra* as well as the knowledge engine *WolframAlpha*. In Elizabeth's class, groups of students were brainstorming about the circumstances that led to Napoleon's rise to power and searched the Internet to identify and explore more ideas. Similarly, in Zoey's class students could search the Internet on their mobile phones to develop ideas while brainstorming about the Mona Lisa reinventions they were asked to create.

The analysis of the documents teachers shared also revealed that using technology to promote idea development and exploration was used by digital pedagogy expert teachers during projects and project-based learning (Ada, Doc. 1., Doc. 2.; Albert, Doc. 1; Rose, Doc. 1; Judith, Doc 1., Doc. 2).

Creating with technology

While the most widely cited technology-enhanced creativity-fostering activity during the interviews was creating with technology, there were only five teachers who implemented such activities with their students during the observed lessons. Anita's students created voice presentations individually or in pairs in her EFL class, Ada's students fashioned multimedia presentations of their solutions and experiments in Physics, students in Judith's observed class were writing collaboratively a synopsis and screenplay in *Google Docs*, Marta's students were creating poetry videos in Hungarian

language and literature, while early finishers of learning activities in Elisabeth's history class could work on their history webpage project. These instances exemplified both domain-specific creative production as well as creativity in the domain of digital communication.

With the exception of Anita's observed lesson in which students started and finished the digital voice presentation during the observed lesson, in other cases students would continue working on their products in subsequent classes. In addition, creating with technology emerged as homework in four cases: Susan's students created their trivia *Kahoot!* quizzes at home, Rose asked her students to create digital crossword puzzles and mindmaps of mathematical concepts as a homework assignment. Similarly, both Zoey and Robert asked their students to create reinventions of famous paintings for the next class.

Creating with technology emerged from document analysis also as a recurrent theme. Project documentations contained references to several artefacts students created with technology such as: memes, posters, ebooks, quizzes, videos, blogs and websites in literary, language, and media projects (Martha, Doc 1., Judith Doc 1.); applications, 3D models, holograms in science projects (Ada, Doc 1., Doc. 2; Albert, Doc 1.); timelines, mindmaps, history games, and website with historical articles in social science (Boris, Doc 1.; Elisabeth, Doc. 1); and 3D models and prints in arts (Zoey, Doc. 1, Doc 2.). In addition, the analysed documents referenced multimedia presentations created by students to showcase their learning (Ada, Doc. 1; Albert, Doc 1.; Boris, Doc. 1; Rose, Doc 1.).

Scaffolding creativity with technology

Ten digital pedagogy expert teachers discussed how electronic environments and digital communication tools allowed the facilitation and orchestration of student creativity. This theme emerged in three observed lessons. Ada and Elisabeth used the collaboration platform *OneNote*, while Judith the *RealtimeBoard* to scaffold students' creative learning with technology. These teachers shared open-ended tasks along with several digital resources students could access during inquiries, and monitored student groups providing guidance when necessary throughout the observed lessons (Ada, Obs.; Elizabeth, Obs.).

Findings of the document analysis highlighted that teachers used technology for scaffolding creative production during project-work and project-based learning with

technology. Technologies facilitating the management of students' creative process identified in the documents included project websites (Martha, Doc. 1), collaborative platforms, such as *Google Drive* (Martha, Doc. 1.; Judith, Doc. 1), *RealtimeBoard* (Judith, Doc. 1, Doc. 2), *OneNote* (Ada, Doc. 1., Doc. 2), *NeoLMS* (Boris, Doc. 1), and *Trello* (Albert., Doc. 1). These shared digital spaces featured open-ended tasks, project milestones, and assessment criteria for learning outcomes and student product ratings.

Augmenting creative collaboration with technology

Seven teachers discussed how digital tools supported co-creation in electronic environments. Technology supported creative collaboration among students was observed in three classes (Ada, Obs.; Elisabeth, Obs.; Judith, Obs.). Ada's students used the collaborative platform to *OneNote* during inquiry-based learning in a project week, Judith's students worked collaboratively on texts in *Google Docs*, while Elizabeth's' students co-created webpages in groups.

Collaborating with technology during creative activities was a recurring theme identified in the documents, too. Students were referenced to use collaborative platforms, e.g. *OneNote* notebook (Ada, Doc1, Doc. 2), *Google Docs* and *Drive* (Judith, Doc. 1; Martha, Doc 1.) to work together on creative tasks as well as to co-create websites (Judith, Doc. 1; Doc. 2; Elizabeth, Doc. 1) across several analysed documents. One of the project pages shared by Martha, for example, featured co-created illustrated short stories as well as student-created project planning documents in *Google Docs*, while the History websites Elisabeth's referenced during the interviews were run collaboratively by student groups (Elisabeth, Int. 2, Doc. 1).

Communicating and evaluating creative outcomes with technology

Nine teachers discussed explicitly that creative student outcomes were presented, published, or communicated through technology in their classes. This theme emerged in three observed lessons (Anita, Obs.; Elisabeth, Obs.; Susan, Obs.). Anita's students, for example, shared their voice presentations with peers and the teacher, and received feedback on the quality and content of their creative products in the EFL class observed. Students' in Susan's EFL class could play each other's *Kahoot!* quizzes. Elisabeth's students presented the history infographics they had created at home and received feedback on accuracy and quality from teacher and peers. In other classes, it was discussed that products created by students would be shared with peers and evaluated

based on product rating rubrics (Ada, Obs.; Judith, Obs.; Martha, Obs.). Creativity as criteria for assessment, nevertheless, was not mentioned in the observed lessons.

Document analysis also revealed the students' creative outcomes were often communicated and evaluated using technology. Several student-created artefacts were featured on websites (Elisabeth, Doc. 1; Judith, Doc. 2; Martha, Doc 1., Zoey, Doc. 2). Project descriptions also referenced multimedia presentations through which students could showcase their learning (Ada, Doc. 1, Doc. 2; Albert, Doc. 1; Boris, Doc 1.; Judith, Doc. 1; Rose, Doc. 1). Nevertheless, document analysis suggested that students' creative development was not measured, while creative outcomes were rarely assessed for their creativity during projects either (Ada., Doc. 1).

Factors influencing technology-supported creativity-enhancement in the classroom

In the interviews teachers discussed several factors that influenced their technology-enhanced creativity-fostering practices. Observations, document, and image analysis also revealed how contextual factors facilitated or hindered the enactment of teachers' beliefs also referenced in the interviews.

Barriers to technology-enhanced creativity development in practice

The analysis of observation data, documents and images highlighted that lack of access to appropriate technology in schools, poor connectivity, technical problems, and the inadequate arrangements of other resources acted as barriers to teachers' technology-enhanced creativity-fostering practices in the classroom.

- Lack of access to appropriate technology

Observation and image analysis revealed that the majority of classrooms (9) in which teachers implemented technology-enhanced creativity-fostering activities with their students were only equipped with teacher-centred technology: teacher desktop computer or laptop, LCD projector or interactive whiteboards (see Table 23 and *Figure 16*). There were two teachers who had access to the schools' computer lab during the observed lessons (Marta, Obs.; Judith, Obs.), while student groups involved in the observation could work with laptops on a regular basis only in one teachers' class (Elisabeth, Int. 1, Obs.). Observation findings also showed that teachers implemented tasks aimed at creating with technology where there was student access to computers

(Ada, Obs., Marta, Obs.; Judith, Obs.), while in other observed lessons students created using digital tools as homework assignment (Susan, Obs.; Robert, Obs.; Rose, Obs.; Zoey, Obs.). One exception was Anita's EFL class, in which students created audio presentations using their mobile phones in class.

In contrast, document analysis showed that the implementation of the technology-enhanced projects which teachers believed to foster creativity required technology not available in teachers' classrooms (Albert, Doc. 1; Boris, Doc. 1; Rose, Doc. 1; Zoey, Doc. 1). A possible explanation for this contradiction was provided, for example, by Rose, who shared that during project-weeks teachers and students often brought their own laptops to school, while special arrangements were also made, namely sharing technology resources on school level so that project-week groups had the resources they needed (Rose, Int. 2). Similar practices were shown in Judith's project plan which indicated that activities involving film editing and website creation during the week-long media project took place in the schools' computer lab (Judith, Doc. 1).

- Poor connectivity

Poor Internet connection was a barrier mentioned by five teachers during the interviews. Observation also revealed connectivity issues in the classroom of three teachers. Bill, for example, had to set up a router in the classroom before the lesson so that his students could connect to the Internet and play a *Kahoot!* quiz using their mobile phones (Bill, Obs.). Judith's students could access with difficulty the *RealtimeBoard* she created to scaffold activities during the lesson due to unreliable and slow Internet connection (Judith, Obs.). Her students also experienced connectivity issues while working collaboratively in *Google Docs* on their synopses and screenplays or accessing online resources (Judith, Obs.). Zoey's students had difficulties to access the Internet through their mobile phones which they used extensively during the lessons. In four other observed lessons in other schools, students used the Internet with no problems identified (Ada, Obs.; Anita, Obs.; Elisabeth, Obs.; Susan, Obs.).

- Technical problems

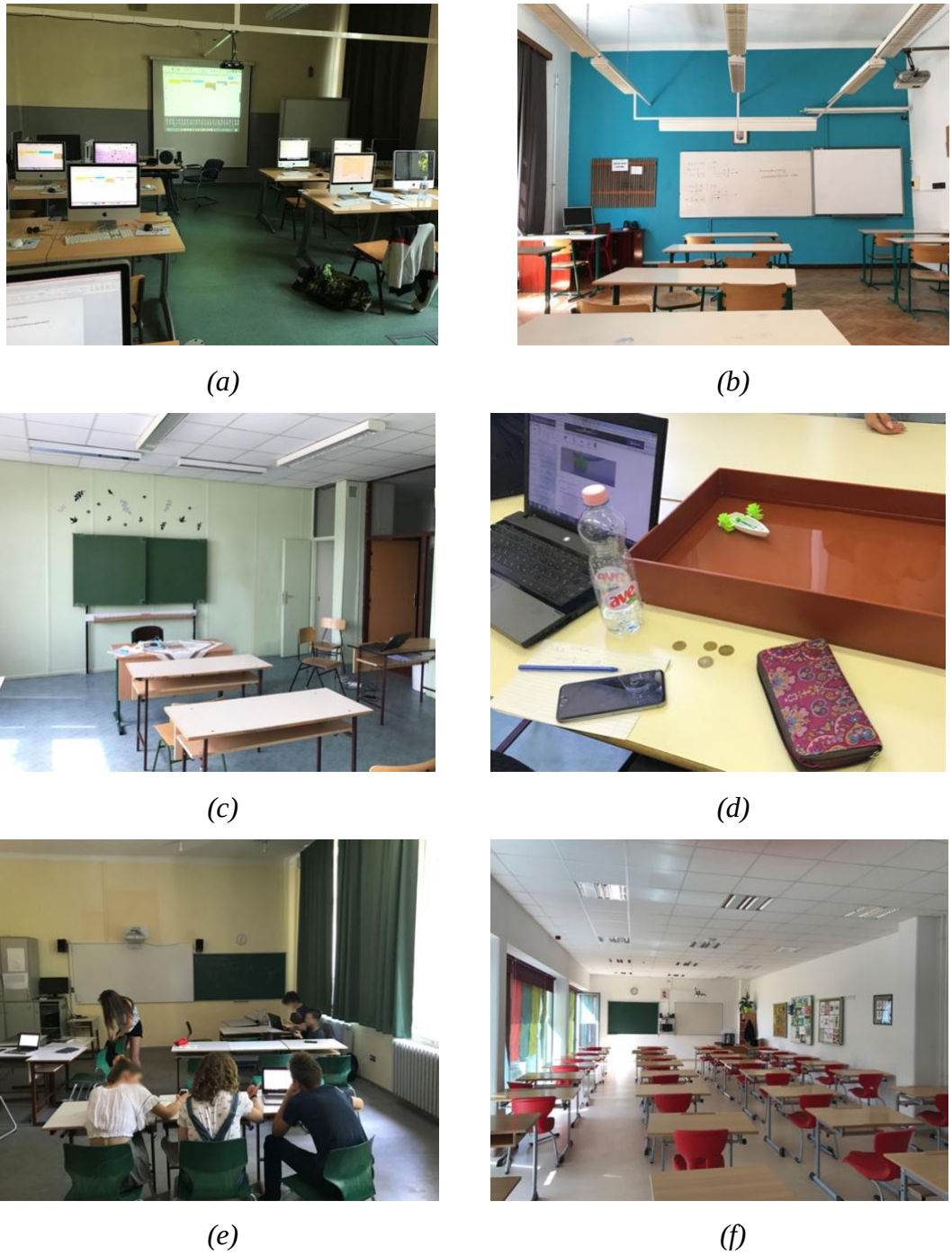
Seven teachers in the interviews discussed how inadequate, unreliable or outdated devices and tools affect their technology-enhanced creativity-fostering practices. Classroom observations also revealed several technical problems during digital pedagogy expert teachers' lessons (Bill, Obs.; Elisabeth, Obs.; Rose, Obs.; Susan, Obs. Zoey, Obs.).

Due to the unreliable functioning of the interactive whiteboard (Rose, Obs.; Zoey, Obs.), and an unexpected software update on the teacher computer (Bill, Obs.) three participants had to deter from their original plans skipping technology-enhanced creativity-fostering tasks (Rose, Obs.) or using offline back-up activities (Bill, Obs., Zoey, Obs.). Other technical problems observed included, for example, student password loss (Susan, Obs.), or file format incompatibility with software installed on school device (Elisabeth, Obs.), which all obstructed the implementation of technology-enhanced activities the teachers planned to implement.

- Inadequacy of other resources

Inadequacy of other resources and their arrangements were considered barriers by six teachers in Study 2. Observations also highlighted inadequate resources affecting teaching and learning for creativity in the classroom (Judith, Obs.; Martha, Obs.). For example, Judith's students could continue working on their synopsis and screenplays, and eventually their movies only during their next scheduled class in the computer lab the following week. Similarly, Martha's students could not move on to editing their poetry videos in the following class since they did not have access to computers in the room they were scheduled.

The physical environment was also considered undesirable by two teachers during the interviews who noted that that it was difficult to implement creativity-fostering collaborative activities in classrooms with traditional seating plans. Observation and image analysis showed that six of the observed lessons took place in classrooms with traditional seating arrangements (See *Figure 16*). Some teachers in these classrooms adopted various strategies to facilitate pair and group work. For example, Martha's students could move freely in the classroom and use common areas in the school as well as outside spaces to plan and record materials for their poetry videos, Zoey's students created pods for group discussions when needed, Anita's students arranged the tables in horseshoe layout at the beginning of the lesson, and returned them to the traditional configuration at the end of the class (Anita, Obs., Martha, Obs., Zoey, Obs.). Other teachers implemented technology-enhanced creativity-fostering activities based on teacher presentation and whole-class discussion and in which students used their devices individually (Bill, Obs.; Boris, Obs., Robert, Obs.).



(a) *(b)*

(c) *(d)*

(e) *(f)*

Figure 16. Examples of learning environments in the observed classes

Enablers of technology-enhanced creativity development in practice

The analysis of observation data and documents identified the use of student devices and teachers' commitment as the most important observable enablers to fostering creativity with technology in the classroom.

- Students' using their own devices

Ten teachers discussed in the interviews that technology-enhanced creativity-fostering activities in the classroom were often implemented using students' mobile phones, while six reported that students regularly carried out certain creativity-relevant activities, more specifically creative production, at home. Observation findings yielded similar results. In more than half of the observed lessons students took part in creativity-relevant activities using their own mobile phones (see Table 23). Such activities were meant to engage students in creative thinking (e.g. the use of *Kahoot!* in Bill's class), supported idea development (e.g. searching the Internet to develop Mona Lisa reinvention ideas in Zoey's class, solving maths problems with the help of micro world *GeoGebra* and knowledge engine *WolframAlpha* accessed through mobile phones in Bill's class, measuring and collecting data in Ada's class), as well as the creation of digital artefacts (e.g. capturing videos and sound for the poetry videos in Martha' class, creating audio presentations in Anita's class), and the evaluation of creative outcomes (sending audio presentations to teacher and peers for feedback in Anita's' lesson, playing student-created *Kahoot!* quizzes in Suzan's lesson). In addition, creative production was often assigned as homework in classrooms where students did not have access to computers or laptops (Robert, Obs., Rose, Obs., Zoey, Obs.).

Document analysis also revealed that students' mobile phones were used during projects (Ada, Doc. 1, Doc. 2; Albert, Doc1., Judith, Doc. 1; Zoey, Doc. 2). These documents also showed that mobile phones were not applied as substitutes for more advanced technology, but as tools with potential to promote students' creativity in their own right.

- Teacher's commitment to fostering creativity with technology in the classroom.

Despite the several barriers discussed by teachers and observed in the classrooms, data from interviews, observations and document analysis showed that digital pedagogy expert teachers valued and therefore, implemented technology-enhanced learning activities likely to promote students' creativity.

5.3.5 Section summary

This section presented the results of the multiple case study conducted in Study 2 to investigate Hungarian digital pedagogy expert teachers' beliefs and experience with regard to fostering creativity with technology. The next section discusses findings of

Study 2 in relation to the existing body of knowledge on teaching and learning for creativity with technology.

5.4 DISCUSSION

The purpose of this section is to discuss the major findings of the multiple case study in relation to the existing body of knowledge within the area of focus of the current study. Themes identified in the interviews and fieldwork are critically discussed and compared to the findings of literature on the intersection of creativity, learning, and technology. First, the findings on teachers' belief about the nature of creativity will be discussed (Section 5.4.1), which is followed by the discussion of the pedagogical beliefs about nurturing creativity with technology across the curriculum (Section 5.4.2). Next, findings on teachers' perception of the barriers and enablers to fostering creativity with digital tools will be discusses (Section 5.4.3), while the subsequent section focuses on the discussion of teachers' enacted beliefs (Section 5.4.4). This section ends with a summary (Section 5.4.5).

5.4.1 Teachers' beliefs about the nature creativity

The first question of Study 2 concerned digital pedagogy expert secondary school teachers' pedagogical beliefs about the nature of creativity. Data analysis revealed that participants' key beliefs referred to three areas: the meaning of creativity (definition), the relationship of creativity with the curricular areas and education levels (specificity), and the nurture of creative potential and measurement (malleability).

Definition of creativity: Overall alignment between teachers' beliefs and scientific theories

Study 2 found overall agreement between teachers' meanings of creativity and the scientific conceptualization offered in the literature. First, throughout the interviews teachers discussed creativity in different contexts, for example as referring to everyday life, teachers' creativity, professionals' creativity in the domains related to the subject areas taught, but mostly in connection with students' creativity in the classroom. These findings suggest that teachers in the present study are aware of the various contexts in

which creativity may manifest, can differentiate between the levels of creative accomplishments identified in the literature, and recognize that the initial levels of the creativity continuum apply to students' creative potential in the classroom (Beghetto & Kaufman, 2007; Craft, 2001).

Second, teachers' conceptualizations of creativity comprised all key elements identified in the literature: person, place, process and product (Rhodes, 1961). In addition, participants endorsed a system view of creativity, acknowledging that students' creative expression arises from the interaction of certain personal characteristics and environmental factors, as suggested by the confluence models in the literature (Amabile, 1983; 1996; Csíkszentmihályi, 1988, 1996; Sternberg & Lubart, 1992).

Third, discussing the criteria for judging creative outcomes, teachers in this study acknowledged both originality and appropriates as joint requirements for creativity, which is in line with the standard definition offered in the literature (Stein, 1953; Plucker et al. 2004). This finding is in contrast with a series of other reports on teachers' belief about creativity, which highlighted that educators tend to emphasize the originality aspect of creativity and often overlook task appropriateness (e.g. Aljughaiman & Mowrer-Reynolds, 2005; Cheung et al., 2003; Diakidoy & Phtiaka, 2002; Fryer & Collings, 1991). Task appropriateness is viewed as related to knowledge, thus when teachers consider creativity only in terms of thinking outside the box, they diminish the contribution of knowledge and skills in developing creative products (Andiliou & Murphy, 2010). The fact that teachers in Study 2 recognized both originality and task appropriateness as necessary for creativity implies that they acknowledge the importance of knowledge and skills in creative production, and nurture creativity within the content of the subject they teach.

Fourth, digital pedagogy expert teachers appeared to be aware of several important personal characteristics which are necessary for creativity, such as curiosity, knowledge, hard-work, risk-taking, intrinsic motivation, and imagination. These attributes, though not discussed by all teachers, are among the most important creative person characteristics highlighted in the literature (e.g. Amabile, 1996; Barron & Harrington, 1981; Beghetto, 2009; Feist, 2010). In addition, teachers also emphasized that creative characteristics need to be cultivated in the secondary classroom, which constitutes an important aspect of creativity-fostering pedagogies (Craft, 2005).

Finally, teachers' conceptualizations of creativity also referred to the environmental aspect of creativity. Environmental conditions identified as important for creativity included idea time, safety and trust, freedom, and especially the balance between freedom and constrains. Teachers beliefs in the present study are thus in line with the findings of the research on the creative environment, which suggests that creativity flourishes where opportunities for exploration and independent work are provided, and where creativity is supported and valued (Kozbelt et al., 2010).

Specificity: Subject- and grade level-specific views of creativity

In addition to discussing creativity in general terms, teachers in this study were also asked to share their thinking about creativity with reference to the subject area and education level they taught. Findings in this respect revealed that though many teachers expressed the view that creativity is easier to find in the arts, they also considered creativity as relevant across the whole curriculum, and were able to establish a clear relationship between creativity and their own curricular area. Thus, no arts bias consolidating creativity to the artistic domains was found in in the present study as opposed to several other studies on teachers' beliefs about creativity (Andiliou & Murphy, 2010). Moreover, findings revealed that teachers in the present study hold subject-specific views of creativity, suggesting that they most likely nurture creativity within the context of the subject they teach.

Many digital pedagogy expert teachers argued that secondary students showed less creativity than primary students, which they explained with fewer creative opportunities in secondary education, students' changing attitudes to creativity, or a decline in certain creativity-relevant characteristics. The decrease in students' creativity during schooling as well as the explanations provided by teachers are addressed in the literature as well. Several studies suggest that schools are not fulfilling students' creative potential which leads to a decline in students' creative capacities (Kim, 2011; Torrance, 1968). Others highlight a discrepancy between the in school and outside of school creative activities and achievements, suggesting that students are not expressing their creativity at maximal level at school (Runco, Acar, Cayirdag, 2017). In addition, students' social preferences, creative attitudes and values, and creative personality traits were also suggested to explain why students often do not display their creativity in the classroom (Runco et al., 2017).

Malleability: Mixed beliefs about plasticity and measurement

Teachers in the study generally believed that creativity can be fostered across the secondary curriculum, also emphasising that higher levels of creativity could be achieved by those who have the necessary dispositions as well as domain-specific knowledge, skills, and talents. Thus, similarly to a previous line of research (e.g. Al-Nouh et al., 2014; Cachia & Ferrari, 2010; Hong & Kang, 2010; Turner, 2013; Zhou et al., 2013) teachers in this study also endorsed a democratic view of creativity acknowledging the creativity can be nurtured to a certain extent in every student. At the same time, a few teachers also discussed that some students cannot be creative in their subject areas, thus associating the concept with talent, which might hinder the development of creativity for every student (Andiliou & Murphy, 2010).

Finally, teachers expressed different views regarding the assessment of creativity, which was seen problematic by many participants due to lack of appropriate measures, to perceived threats proposed by inappropriate measurement, or because teachers believed that the concept could not be measured. Others studies also highlighted educational stakeholders' beliefs that creativity is at odds with assessment (e.g. Polston, 2016). Thus, while measures of creativity have been used in research for decades (Kaufman et al., 2008) and assessments for classroom exist (Skiba et al., 2017), these still need to be scaled and further developed to fit classroom use.

5.4.2 Teachers' beliefs about fostering creativity with technology

Literature suggests that technology can make a distinctive contribution to the development of creativity in education through providing new tools, media, and environment for learning to be creative and learning through creativity (Glăveanu et al. 2019; Loveless, 2003, 2007; Lubart, 2007). Yet, as the literature review section of the present dissertation revealed, little is known about how students' creative capacities are fostered with technology in schools. The second research question of Study 2 thus focused on digital pedagogy expert teachers' beliefs about and experiences with fostering creativity through technology across the secondary curriculum.

Data analysis revealed six themes in teachers' pedagogical beliefs about fostering creativity with technology. Technology-enhanced activities identified by teachers to promote student creativity thus included: engaging students in creative thinking,

supporting students' idea development and exploration, diversifying creative expression, scaffolding creativity, augmenting collaborative creativity, and increasing relevance through the communication and evaluation of creative outcomes. In addition, Study 2 exposed several pedagogical strategies and methods teachers found effective when nurturing creativity with technology, which ranged from lectures, dialogues, or project work to more complex learner-centred strategies (inquiry-, project-, problem-, and design-based learning).

Igniting creative thinking with technology: A wealth of possibilities with digital resources

Eight of the 12 teachers in Study 2 believed that technology, more specifically digital resources could inspire and motivate students to engage in creative thinking across the curriculum. Interesting digital resources curated or created by teachers or the students themselves were believed to offer starting points for discussions promoting divergent thinking, whereas others were found valuable in providing motivation and inspiration for future creative work. The role of using digital resources to promote creativity is acknowledged in the literature too. Loveless (2003, 2007) argues that there are several online resources which may inform students' creative ideas and thus promote their creativity. On the other hand, research on the use of digital resources to engage students in creative thinking and inspire their creativity is scarce, while previous studies addressing teachers' beliefs about fostering creativity with technology do not share specific findings in this respect (e.g. Adams, 2013; Alsahou, 2015; Cachia & Ferrari, 2010; Hondzel, 2013; Shen, 2014; Tomasevic & Triptic, 2014).

Developing and exploring ideas with technology: Technology-enhanced creative thinking

Another approach viewed to promote students' creative thinking by eight teachers in Study 2 refer to those technology-enabled activities that support imaginative conjecture, exploration, and the representation of ideas during inquiry-based, problem-based, practice-based and design-based learning. Science teachers in this study believed that microworlds, simulations, and knowledge engines (e.g. *GeoGebra*, *PhET*, *Intellisense*, *Yenka*, *WolframAlpha*) enable students to explore phenomena, processes or systems which otherwise would be impossible, while devices and tools to capture, collect,

represent, and analyse data (e.g. *micro:bit*, *LabCamera*) could promote scientific creative thinking during real-life science inquiries, and experiments. Maths teachers also agreed that technology could assist students to generate and test ideas during mathematical problem solving (e.g. *Geogebra*, *WolframAlpha*). The benefits of serious games available for history classes was highlighted by social science teachers, while creation tools were seen to support student idea generation and testing when creating in arts and language arts.

Digital pedagogy expert teachers' beliefs about the potential of technology to support idea development and exploration have been reinforced by several theoretical works (Glăveanu et al., 2019; Loveless 2003; 2007; Lubart, 2005; Nikolopoulu, 2015; Mishra et al., 2013) and a few empirical studies (Chang, 2013; Hsiao et al., 2014). Loveless (2003, 2007), for example, argues that activities using simulations and control technology may promote imaginative play, exploration, testing ideas and approaches to problem-solving, risk-taking in conjecture, and making connections between ideas, thus contributing to students' creative development across the curriculum. Glăveanu et al. (2019) suggests that computers may work in partnership with learners by contributing to the generation, evaluation, and refinement of ideas. Empirical studies suggest that technology can be used effectively to foster creativity in problem-based and game-based learning (Chang, 2013; Hsiao et al., 2014).

Creating with technology: Expressing digital and/or subject-specific creativity

Creating with technology was the most widely cited theme of nurturing creativity with digital tools with eleven of the twelve teachers arguing that creating digital outcomes promoted students' creativity. Digital pedagogy expert teachers thus indicated that they offered students several opportunities to express their learning and creativity through digital creation across the curriculum either individually or in collaborative teams. Digital products created by students during project work, or more complex learner-centred instructional strategies, included digital images, videos and animations, multimedia presentations, timelines, mindmaps, infographics, games and quizzes, blogs, podcasts, wikis, webpages, 3D models, programming codes, VR/AR products etc. Findings also showed that the creation of many of these products involved students to build both knowledge and develop subject-specific creativity. For example, when creating digital artwork in arts, expressing ideas through various media in language arts, creating a

podcast for an international audience in English, building 3D models in science, students could be creative within certain domains, similarly to professionals in the given domain. In other activities, students were asked to create digital products to express their learning in creative ways. Students, for example, were reported to create multimedia presentations to demonstrate their understanding of a topic, or to present the procedures and outcomes of projects. Such activities could promote students' learning in the subject area as well as their creativity in the domain of digital communication.

The potential of technology to foster creativity through creating digital outcomes was highlighted in the literature, too (Loveless, 2003, 2007). At the same time, the analysis of the empirical research base showed that only few studies measured the effects of creating with technology on students' learning and creativity in K-12 settings or identified variables that would mediate or moderate the effectiveness of such practices (Scott, 2004a, 2004b). Teachers in this study provided several examples of activities and tools that could be used to promote creativity by allowing students to create with technology across the secondary curriculum, the effectiveness of which as well as their implementation in other settings needs to be examined.

While several creativity researchers argue the creating purposeful outcomes across the curriculum represents a viable way of nurturing creativity in students (Cropley, 2011; Craft, 2005; Renzulli, 2017), others highlight that teachers' artistic product bias, which consolidates creativity to art-based or art-influenced products as well as their general product bias, i.e. the view that creativity requires the production of tangible outcomes, could act as barriers to fostering creativity within all subject areas, and in all students (Andiliou & Murphy, 2010; Beghetto, 2010; Runco, 2007). Teachers in this study viewed tasks in which students were invited to create digital products as important, but not sole creativity-fostering activities. Also, while many activities identified by teachers asked students to create digital products expressing their domain-specific creativity, others invited them to show their learning through being creative in the domain of digital communication. This may point towards a digital product bias in teachers' views, however, given the emphasis on teaching digital competence and creative expression through digital tools in education (European Commission, 2018; HNCC, 2010; Redecker & Punie, 2017), we suggest that both types of activities may have a place in the classroom.

Scaffolding creative learning with technology: Blended creativity

Another widely cited theme was scaffolding students' creativity through digital communication and collaboration technologies. Ten teachers in the study believed that technology could offer tools to facilitate students' creativity in the classroom as well as beyond it. Technologies applied for such purposes ranged from electronic communication tools (e.g. email and *Skype*), social media tools (*Facebook* groups), collaborative platforms (e.g. *Google Drive*), and learning management systems (e.g. *NEO LMS*, and *Spiral*). Teachers in the study believed that students' creativity could be promoted using these technologies in various ways, for example, by sharing open-ended creative tasks as homework with students, providing personalized feedback to students' creative ideas and work, mentoring students during creative processes, or facilitating online communication, and collaboration creative activities.

Teachers' beliefs about the potential of technology to support the management of creative learning is similar to views expressed in the literature. Glăveanu et al. (2019), for example, argue that technological tools may act as 'nannies' in the creative learning process in that digital applications could help monitor students' creative work processes, offer engaging electronic environments, or create conditions favourable to its expression. Empirical evidence also suggests that technology may be used to orchestrate creativity beyond the classroom (Benedek et al., 2006; Chang, 2013; Hsiao et al., 2014; Robins & Kegley, 2010; Stolaki & Economides, 2018).

Collaborating with technology: Augmenting co-creation

Study 2 revealed that though collaboration was considered an important aspect of nurturing creativity with technology by teachers who discussed that their students often worked together on creative tasks, the role of digital tools in facilitating collaboration was vaguely addressed. Nevertheless, teachers reported several activities in which students co-created in electronic environments working together, for example, on shared documents, presentations, blogs, wikis, webpages, while one teacher emphasized the value of her students collaborating with others beyond the school, also noting that due to time constrains such practices were rare in her classes.

Researchers have argued that technology may promote creativity by facilitating the act of communication and collaboration during the creative process by allowing learners

to share perspectives which potentially lead to creative insights (Glăveanu et al., 2019; Loveless 2003; 2007; Lubart, 2005; Nikolopoulu, 2015; Mishra et al., 2013). Glăveanu et al. (2019) highlighted that taking part in diversified collaborative projects involving heterogonous teams could considerably enhance creativity and learning. Technology-enhanced learning opportunities in diverse groups still need to be addressed by teachers in this study.

Communicating and evaluating creative outcomes with technology: Looking for balance between relevance and safety

Nine teachers in this study believed that the technology-enabled communication of creative student outcomes could support creativity-development. Digital technologies that teachers viewed to support these types of activities ranged from classroom presentations to sharing work using Web 2.0 tools (blogs, podcasts, webpages), or social media sites (e.g. *Facebook, Youtube, Instagram*). Teachers argued that students could present or share their creative outcomes with various audiences, while such activities could have different purposes. The accounts of teachers revealed that students' creative outcomes were often presented to or shared with peers as well as with wider audiences online. In addition, five teachers reported that products were sometimes created for a specific audience, which allowed for realistic assessment of creativity. One teacher highlighted that creating for and sharing creative outcomes electronically with others should always be treated with caution, highlighting that some students may not be ready to take the risk of communicating their creativity. While the majority of teachers saw a value in showcasing and celebrating creativity through digital tools, how the evaluation of or feedback to students' products was used for further creativity development was rarely addressed.

Using technology to present, publish, and communicate the outcomes of the creative process is also acknowledged in the literature (Loveless, 2003; 2007). Loveless (2007) argues that technologies may enable students to celebrate and present their work to a range of audiences, while considerations of purpose and audience may lead to more detailed and careful evaluation of creative work. The literature on pedagogical environment conducive to creativity also suggests that offering students authentic learning opportunities as well as relevance can promote creativity (Craft, 2005; Davies et al., 2013). Indeed, creating for and communicating creative outcomes through technology

with a range of audiences may offer relevance to students' creative production, nevertheless it may conflict with the principle of maintaining a safe environment as highlighted in this study.

5.4.3 Perceived barriers and enablers to fostering creativity with technology

The implementation of teachers' beliefs is influenced by internal and external supports and challenges (Fives & Buehl, 2012; Kagan, 1992; Pajares, 1992). The third research question of Study 2 focused on the identification of the constrains and facilitators that digital pedagogy expert teachers perceived to fostering creativity with technology across the secondary curriculum. Findings revealed that teachers in Study 2 perceived a range of barriers and few enablers to technology-enhanced creativity development in the secondary school.

Barriers to technology-enhanced creativity development: There is a lot to overcome

Current findings revealed a number of factors that might intervene in translating teachers' positive and adequate beliefs about creativity into technology-enhanced creativity-fostering practices. Constrains were categorized into five major themes: system-related, culture-related, other-resource related, interpersonal, and those internal to the teachers. It is important to note that there was a degree of overlap between the constraining factors, for example system-related barriers often generated pedagogical culture-related or interpersonal ones which in turn created personal constrains. Most important barriers identified by the majority of teachers included: packed and restrictive curriculum, creativity-stifling pedagogical culture, lack of time, limited access to appropriate technology, students' attitudes to creativity in education, and final exam pressure. The research also revealed some contextual variations between teachers' responses.

System-related barriers

Educational system-related factors perceived as barriers to fostering creativity with technology included: packed and restrictive curriculum, lack of time, final exam and standardized assessment pressure, large class-sizes, heavy workload, and inadequate professional development opportunities. The majority of teachers in Study 2 felt that

curricular and final exam demands conflicted with their intentions of fostering creativity with technology in the classroom. These barriers were often stated together with lack of time, large class-sizes, and heavy teacher workload, though there were certain variations among teachers based on their specific contexts, with EFL teachers perceiving the fewest barriers. Time constrain was argued to be even more emphasized with technology-enhanced creativity development, which requires more time investment both in planning and implementing creative activities integrating digital tools.

Research on teachers' perceptions on the factors that mediate creativity beliefs in education conducted in other countries has provided similar results. Several studies have shown that though teachers value creativity, lack of time, overloaded curriculum, and exam pressure act as major barriers to their intentions (e.g. Aish, 2014; Al-Nouh et al., 2014; Alsahou, 2015; Cachia & Ferrari, 2010; Cheng, 2010; Fairfield, 2010; Frawley, 2014; Hondzel, 2013; Hong & Kang, 2010; Kampylis et al., 2011; Scott, 2015; Shaheen, 2011; Zhou et al., 2013). Researchers have also highlighted that fulfilling the demands of a packed curriculum promote convergent teaching practices and leave little place for creativity in the classroom (Skiba et al., 2017). This view resonates well with teachers experience and perceptions in the present study.

Culture-related barriers

There was only one culture-related barrier emerging from data analysis and it referred to the pedagogical culture. The majority of teachers identified Hungarian pedagogical culture as unsupportive of students' creative development. Participants explained that Hungarian teachers tend to employ teacher-centred activities, prefer complete control over students, emphasise factual knowledge, and teach for the final exam. Such practices were argued to offer little or no opportunities for students to explore and express their own ideas, who thus may become reluctant or not willing to be creative at school. Traditional teaching practices as barriers to fostering creativity were identified in other countries as perceived barriers to creativity in education (e.g. Al-Nouh et al., 2014; Cheng, 2010; Fairfield, 2010; Scott, 2015; Shaheen, 2011). Similarly to participants across these studies, educators in the present study also emphasised that pedagogical culture-related barriers were strongly related to system-level constrains. Creativity literature also suggests that constrains presented by packed restrictive curricula and high stakes exams create an environment in which there are incentives for teachers to promote conformity in the classroom to reduce disruption and fulfil external demands (Kim, 2008).

Technology-related barriers

Data analysis illustrated three technology-related constrains to nurturing creativity: limited access to computers at school, inadequate technology, and limited or no access to the Internet. These factors have been identified as considerable constrains to technology-enhanced teaching and learning across several studies conducted both in Hungary (e.g. Tóth, Molnár, & Csapó, 2011; Government of Hungary, 2016) and in other countries (e.g. Ertmer, Ottenbreit-Leftwich, Sadik, Senduur, & Senduur, 2012; Hechter & Fermette, 2013; Hew & Brush, 2007; Ottenbreit-Leftwich, Liao, & Ertmer, 2018). With three exceptions, all teachers reported a lack of access to appropriate technology, while if available, technology was often limited to computer labs. Students' mobile devices were in some cases banned by the school, while in other cases these could not be used due to poor or no Internet connection. Even though teachers in this study were experts in the use of educational technology for teaching and learning with commitment to implement technology-enhanced creativity-fostering activities, the technology-related factors identified by many participants along with the system-level constrains represent substantial barriers to overcome.

Other resource-related barriers

Lack of suitable resources and inadequate arrangements were also identified by teachers as barriers to fostering creativity with technology with contextual variations among the participants. Constrains in this respect included class duration, difficult access to computer labs, inflexible physical environment, and scarcity of teaching materials to support technology-based creativity-fostering practices. Research suggest that physical environment and the availability of various resources have an important role in supporting creativity in the classroom (Davies et al., 2013). The attention to such arrangements in schools could increase the likelihood that teachers implement technology-enabled creativity-fostering activities more easily.

Interpersonal barriers

Considerable evidence emerged about the existence of interpersonal barriers to nurturing creativity with technology perceived by teachers in this study, which were related to students' and parents' beliefs and values of creativity in education.

The majority of teachers identified some student-related constrain to creativity, reporting that students were often reluctant or not willing to participate in creativity-fostering activities in the classroom. Students' lack of engagement was also described as

a barrier by teachers in other studies (e.g. Cheng, 2010; Shaheen, 2011; Snell, 2013). Two important causes identified were students' risk-avoidance and low creative-self efficacy beliefs. Sharing novel ideas, asking questions, trying out new things involve uncertainty placing students at the risk of making mistakes, who thus may appear less competent or feel inferior to others, which may, in turn, underwrite conforming and risk-avoidant behaviours in the classroom (Beghetto, 2010). In addition, creativity also requires students to have confidence in their ideas to share them and make them available for feedback (Beghetto, 2010). Teachers in the current study stressed the importance of an environment which promotes safety, trust, and mutual respect and recognized that some students need to gain creative confidence, nevertheless only few reported to cultivate such self-beliefs in students.

Another student-related constrain raised by teachers in the study was that some students simply did not want to be creative in school. It seems that for many students in the face of final exam preparation and the overwhelming importance of grades, creativity becomes irrelevant or simply out of place (Kaufman & Sternberg, 2007; Rubenstein et al., 2013). Dealing with such attitudes places extra pressure on educators committed to promoting creativity in the classroom.

Certain parental attitudes and expectations were also identified as barriers, a finding also reported in studies conducted in other countries (e.g. Alsahou, 2015; Cheng, 2010; Fairfield, 2010; Shaheen, 2011). Parents' traditional beliefs about teaching and learning as well as their view that passing the examination is the measure of success in life, thus may discourage teachers' from implementing creativity-fostering initiatives.

Internal barriers

Data analysis illustrated two barriers internal to the teachers, namely their insecurity about nurturing and assessing creativity in general, and using technology to foster creativity in particular. These personal constrain were, nevertheless, reported by only few teachers in the current research. It is important to note, nevertheless, that the sample of Study 2 was distinct, since digital pedagogy exemplary teachers might have more knowledge about and confidence in their ability of integrating technology to foster various 21st century student outcomes, among which creativity is one of the most desired (Lai et al., 2018).

Several other studies found that educators identify to possess limited knowledge about creativity (Alsahou, 2015; Hong & Kang, 2010) as well as perceive teaching

creativity skills as a challenge (Cheng, 2010; Fairfield, 2010; Hong & Kang, 2010; Shaheen, 2011; Snell, 2013). Some creativity researchers also argue that educators lack the training to promote creativity, and often rely on intuitive approaches that are based on misconceptions about the nature of creativity which result in inadequate creativity-fostering practices (Andiliou & Murphy, 2010; Beghetto, 2010; Plucker et al., 2014; Skiba et al., 2017). The present study does not support this view. Participants in Study 2, though did not have extensive formal training in fostering creativity, their beliefs about creativity and its nurture were found to be in overall alignment with scientific theories and research-based practices.

Enablers: There are some to keep going

While educational technology expert teachers in this study discussed a range of barriers that might intervene in translating their beliefs into creativity-fostering classroom practices, they mentioned only few enablers. These were also categorized into system-related, culture-related, technology-related, interpersonal, and personal enablers. It is important to note that teachers often identified as enablers factors that helped them overcome the constrains of teaching for creativity with technology. Most widely cited enablers included the use of students' mobile devices during technology-enhanced creative activities, and students' positive attitudes to technology-enhanced learning.

System-related enablers

Only few teachers in the study indicated that education system-related factors supported fostering students' creativity with digital tools across the secondary curriculum. These included: the availability of adequate non-traditional professional development for teachers on the topic (self-directed, collaborative, practice-based), freedom in some areas and aspects of the curriculum (content, methods), and small group sizes in certain contexts. Earlier studies also highlighted that teachers generally perceived few system level facilitators to creativity (Aish, 2014; Al-Nouh et al., 2014; Alsahou, 2015; Cheng, 2010; Hondzel, 2013; Hong & Kang, 2010; Scott, 2015; Shaheen, 2011; Zhou et al., 2013). In line with other studies conducted around the world, findings of this study also suggest that there is need for more consideration of creativity at the education system level.

Culture-related enablers

Pedagogical culture emerged also as an enabler of technology-enhanced creativity-fostering practices. Participants believed that the pedagogical culture in Hungary is changing, with more and more educators and schools recognizing the value of creativity in education, arguing nevertheless that system-related constraining factors still prevented the implementation of creativity-fostering practices in schools. It is interesting to note that while a creativity-promoting school culture could support teachers as well as ameliorate some of the effects of systemic constrains (Adams, 2013; Hondzel, 2013), teachers in this study did not discuss this aspect.

Technology-related enablers

The perceived technology-related enablers to fostering creativity across the secondary curriculum discussed by teachers were related to access to technology and could be organized into two categories: students' access to technology through their own mobile devices and students' access to technology through their home devices. In the absence of appropriate devices at school many digital pedagogy expert teachers in this study implemented technology-enhanced creativity-fostering activities in the classroom which relied on student-owned mobile-devices. Teachers at the same time argued, that mobile-devices could not substitute computers and laptops, especially when the creation of more complex digital product was involved. Also, participants shared that certain creativity-relevant tasks, and especially creative production, were often carried out by students outside the school. Thus, while students' home access to technology acted as enabler to fostering creativity with digital tools, it also seemed to represent a constrain due to the extra time and effort that needed to be invested in technology-enhanced creative tasks beyond the school.

Interpersonal enablers

Two themes emerged as interpersonal enablers: positive student attitudes to technology-enhanced learning and creativity-fostering activities. Several teachers in the study believed that students generally had positive attitudes towards working with appropriately chosen technology and many enjoyed taking part in creative activities. Similar perceptions of teachers in relation to creativity were reported in other studies (Adams, 2013; Alsahou, 2015). Student attitudes to technology have also been identified as important factors affecting the success of learning with technology (e.g. OECD, 2010; Petko, Cantieni, & Prasse, 2016), while students' creativity-related beliefs and values

have been suggested to influence their participation in creativity-fostering activities (Beghetto, 2010).

Internal enablers

Three themes emerged as enabling factors related to the teachers, namely their willingness to bend rules to infuse creativity in their classes, their sense of being appreciated for implementing creativity-fostering practices, and educators' own creativity. Highly accomplished teachers in other studies also expressed the belief that bending or breaking the rules is necessary to foster creativity in restrictive educational climates (Henriksen & Mishra, 2015). In addition, findings reinforce the belief that fostering students' creativity requires creative teachers, which was also expressed by educators in the other studies (Henriksen & Mishra, 2015; Scott, 2015; Merriman, 2015), and a view emphasized in the literature (Jeffrey & Craft, 2004; Lin, 2011).

5.4.4 Teachers' enacted beliefs of nurturing creativity with technology

Beliefs tend to influence teachers' general pedagogical practices (Fives & Buehl, 2012; Kagan, 1992; Pajares, 1999) as well as their specific creativity-fostering (Adams, 2013; Alsahou, 2015; Lasky & Yoon, 2011), and technology-integration practices (Ertmer, Ottenbreit, & Leftwich, 2010; Tondeur, Hermans, van Braak, & Valcke, 2008). The fourth research question concerned Hungarian digital pedagogy expert secondary school teachers' enactment of their beliefs about nurturing creativity with technology in the classroom. Study 2 investigated the link between teachers' beliefs and practices using data from interviews, classroom observations, document, and image analysis. On the whole, findings show general congruence among teachers' beliefs about creativity, its technology-supported enhancement, and classroom practices in several areas, with only few incongruences identified. The analysis also provided further insights how enablers and challenges influenced and shaped the implementation of teachers' beliefs in the classroom.

General alignment between beliefs about the nature of creativity and practice

Teachers in this study expressed several beliefs about creativity in alignment with scientific theories which they could also translate to classroom practices.

All teachers in this study defined creativity in terms of originality and appropriateness, thus recognizing the importance of skills and knowledge in creative production. This belief was clearly reflected in teachers' practices, who all cultivated creativity in conjunction with academic learning during the observed lessons. Though several participants expressed that creativity is easier to find in the arts, observed and inferred practices showed that teachers did not confine creative activities to the domain of the arts. On the contrary, digital pedagogy expert teachers expressed subject-specific views of creativity, and, accordingly creativity-fostering approaches in their practice were embedded in the context of and specific to the subject they taught. Several teachers in the study also acknowledged that creativity from other domains not directly linked to their curricular area may be fostered in class, a view also reflected in these participants' practice.

Teachers in Study 2 agreed that creativity can be nurtured in every student to some extent, while higher levels may be achieved by students who have the necessary dispositions and domain-specific knowledge. Observation and document analysis showed that the majority of teachers implemented creativity-fostering activities with all students in regular classes, though some teachers chose advanced course student groups for the observation.

Beliefs about assessment emerged from interviews as an area in which teachers expressed different perspectives: while many argued that creativity should or could not be assessed, others held contrary views. Classroom observation and document analysis revealed that students' creativity or the creativity of student outcomes were rarely discussed or assessed per se (only in Ada's case), suggesting that teachers might need support to review their beliefs and implement research-based creativity assessment practices.

Finally, establishing alignment between certain emerging beliefs and practice was not possible based on the available data. Observation data revealed that there might be some difference in certain teachers' espoused beliefs and enacted practice in terms of the environmental conditions necessary for creativity: while many teachers argued that freedom is necessary for creativity, three of them implemented modest student-centred approaches in the observed classes. Also, teachers identified safety and trust as necessary conditions of a creativity-fostering environments, and though observation revealed

aligned practices, this might not be true for all students. More targeted data collection could provide further insights in this respect.

Alignment between the conceptualization of creativity and creativity-fostering practices have been shown in the literature before (Adams, 2013; Lasky & Yoon, 2011). In a multiple case study conducted with primary teachers Adams (2013) highlighted that the way participant conceptualized creativity was reflected in the examples of classroom activities they provided. Similarly, in a grounded theory study Lasky and Yoon (2011) found that teacher's views, both those aligned with creativity research and those based on misconceptions were evident in classroom practices. Other studies highlighted that teachers' enactment of creativity beliefs are hindered by individual and contextual factors (Alsahou, 2015; Cheng, 2010; Gralewski, 2018). Insecurities about how to assess creativity may thus represent an internal barrier which should be payed special attention to at the level of the teacher education and professional development.

Alignment between beliefs about technology-enhanced creativity fostering and practice

Interview analysis identified six themes with regard to technology-supported creativity enhancement which were also reflected in teachers' practices examined through classroom observations and document analysis. Teachers in the observed lesson implemented technology-enhance creative activities aimed at igniting students' creativity and engaging them in creative thinking through discussions based on digital resources. Students also had the opportunity to create digital products which required them to use or build subject-specific knowledge and skills or to showcase their learning, in groups or individually. In many cases, nevertheless, creating with technology was carried out at home due to lack of appropriate technology, unreliable technology, and time as an individual task. Creative activities in which students worked with technology to develop and explore ideas were also observed in the classroom often involving students' own mobile phones. Creative student outcomes were presented, published, or communicated through technology, while scaffolding creative activities and technology-enhanced collaborative task were rarely observed. Document analysis revealed that teachers used all six identified activities during project-based learning and longer projects.

The impact of barriers

The enactment of teachers' beliefs is supported and hindered by individual and contextual factors (Fives & Buehl, 2012; Kagan, 1992; Pajares, 1999). Digital pedagogy expert teachers in this study identified a range of barriers and a few enablers to fostering creativity with technology across the secondary curriculum. Data derived from classroom observations, document, and image analysis, provided further insights how supports and challenges influenced and shaped the implementation of teachers' beliefs in the classroom.

Findings based on observation data, document, and image analysis confirmed that digital pedagogy expert teachers in this study encountered serious technology- and resource related barriers to fostering creativity with technology in their schools. The overwhelming majority of classrooms were equipped only with teacher-centred technology, while laptops or computers were available to students on a regular basis only in one case (Elisabeth). In addition, poor internet connection, unreliable technology as well as inadequacy in scheduling and inappropriate physical arrangements also affected creative learning with technology. Despite these barriers, and the additional one's identified during the interviews, digital pedagogy expert teachers seemed to value and implement technology-enhanced creativity-fostering activities building on existing resources and supports. The reliance on students' own devices and teachers' commitment to nurture creativity with technology emerged as most important enablers of technology-enhanced creativity-development from observation and document analysis, too. Thus, in more than half of the lessons observed teachers designed creativity-fostering activities in which students used their own mobile phones. Mobile technology in these activities was applied as a tool to engage students in creative thinking, support idea development, aid the creation of digital artefacts, and evaluate creative products, while technology-enhanced activities which required more powerful devices or large screens were implemented in classes scheduled in the computer lab, or, in the absence of appropriate technological resources and time in school, carried out as homework.

Findings of the current study are in line with previous research on teachers' beliefs and practices of using technology for learning, according to which first order barriers, namely external challenges related to the lack of technology resources, training, and support pose significant barriers to achieving technology-integration (O'Mahony, 2003, Pelgrum, 2001), nevertheless second-order barriers, that is teachers' lack of confidence,

traditional beliefs about learning, and negative attitudes to technology represent even greater challenges (Ertmer, 1999; Ertmer, Addison, Lane, Ross, & Woods, 1999; Newhouse, 2001). Barriers for teachers in this study tended to be first-order, while their beliefs about creativity and technology acted more as facilitators than obstacles to nurturing creativity with technology in the classroom. Literature, nevertheless also suggests that a barrier threshold still may exist and practices can be limited despite beliefs. Ertmer et al. (2012) showed that even award-winning technology-integrators working in schools with very limited access to technology may have difficulties in aligning their beliefs with practice, which seemed to be the case with several teachers in the present study.

5.4.5 Section summary

This section discussed the major findings of multiple case study on digital pedagogy expert teachers' beliefs about creativity in relation to the existing body of knowledge within the area of focus of the current study. The next section (Section 5.5) will present the conclusions drawn from the qualitative multiple case study.

5.5 CONCLUSIONS

The purpose of Study 2 was to investigate the relationships between creativity, technology, and learning by exploring educational technology expert secondary school teachers' beliefs about and experiences with nurturing creativity in technology-integrated learning environments across six areas of the secondary school curriculum: EFL, Hungarian language and literature, mathematics, science, social studies, and visual arts. Study 2 applied multiple case study design to answer the research questions, involved 12 digital pedagogy expert teachers identified through purposeful sampling, and collected data using interviews, classroom observations, document, and image analysis.

Overall, the following conclusions can be made based on the multiple case study. First, digital pedagogy expert teachers in this study held several beliefs that could act as facilitators to promoting creativity in the classroom, such as they were aware of the various contexts in which creativity occurs in education, could differentiate between its different levels and domains, and endorsed a system perspective acknowledging that students' creativity arises from the interaction of certain personal characteristics and the

environment. In contrast with more traditional classroom teachers (Andiliou & Murphy, 2010), but in line with other highly accomplished ones (Henriksen & Mishra, 2015; Merriman 2015; Scott, 2015), educators in this study also recognized that creativity requires both originality and appropriateness, and could clearly establish its relationship with their own subjects. All this suggests that teaching for creativity is related to high quality teaching, and so expert teachers may play an important role in promoting research-grounded beliefs among educational stakeholders. An important area in which teachers in Study 2 needed further support was creativity assessment, an aspect of creativity education which may be problematic even for exemplary teachers, and, therefore, special emphasis should be placed on developing and promoting research-based creativity assessment and measures for K-12 education.

Second, Study 2 identified six types of technology-enhanced activities digital pedagogy expert teachers believed were valuable for fostering creativity across the secondary curriculum: (1) igniting students' creative thinking with technology, (2) developing and exploring ideas with technology, (3) creating with technology, (4) scaffolding student creativity with technology, (5) augmenting collaboration with technology, and (5) communicating and evaluating creative outcomes with technology. The identified themes were in line with the theoretical work on creativity, technology, and learning (e.g. Glăveanu et al., 2019; Loveless 2003; 2007; Lubart, 2005), yet Study 2 could establish a new framework for technology-enhanced creativity fostering activities which reflects the realities of classroom practice. While teachers' beliefs about technology-enhanced creativity-fostering activities were in line with theory, a gap between practice and research has been highlighted. In addition, Study 2 identified several creative activities supported by digital tools, the effectiveness of which could be explored by future research.

Third, digital pedagogy expert teachers in Study 2 perceived several barriers and few enablers to fostering creativity with technology at system, culture, interpersonal, and personal levels. Most cited barriers were those external to the teachers: packed restrictive curricula, often discussed together with lack of time and final exam pressure, lack of student access to appropriate technology in schools, a creativity-stifling pedagogical culture, and students' creativity-related attitudes, values, and beliefs. Most important enablers included students' use of their own devices in the classroom and at home, students' positive attitudes to technology and non-traditional professional development

opportunities. Such supports and facilitators mediate how teachers translate their technology-enhanced creativity-fostering belief into classroom practices.

Finally, findings on teachers' beliefs-in-action showed that beliefs about creativity and its nurture with technology is reflected in classroom practice while their enactment is dependent on factors both internal and external to the teachers. Based on Study 2 it can be concluded that a barrier threshold (Ertmer et al., 2012) exists in the enactment of teachers' beliefs, and technology-enhanced creativity-fostering practices can be limited despite beliefs.

5.5.1 Limitations and future directions

There are several limitations associated with this study. First, limitations include those commonly associated with case studies. Thus, findings of the current research are not appropriate for generalization. Instead of generalizability this study supports transferability as described in the methodology section. By providing a detailed description of the participating digital pedagogy expert secondary school teachers' beliefs and experiences of nurturing creativity with technology and their contexts others can evaluate the extent to which conclusions drawn are transferable to other situation, times, and settings.

Second, given that teachers in this study were selected based on their expertise in digital pedagogy, implications may apply only specifically to this population. Hence, Study 2 may provide little insight into beliefs and practice for teachers who are at lower level of technology integration. Nevertheless, digital pedagogy exemplary teachers were specifically chosen as the population of the present study due to their special role in informing both research and practice about technology-enhanced creativity-fostering activities valuable for the classroom as well as for their expert insights on the barriers and enablers that may influence such practices in different contexts. Future studies, then, could focus on exploring more traditional classroom teachers' beliefs and practice as opposed to those with high levels of educational technology use. In addition, teachers involved in the study taught specific subjects in secondary schools, which may also limit the range of implications. Subsequent research on teachers' belief and experience of nurturing creativity with technology would benefit from involving primary school teachers, too.

Third, Study 2 is subject to several methodological limitations. The descriptions of Hungarian digital pedagogy expert teachers' beliefs and experiences with regard to fostering creativity with technology were supplemented with classroom observations, image, and document analysis to reveal the relationship between teachers espoused and enacted beliefs. Nevertheless, due to limited funds, time, and participant access, only one site visit was coordinated for each teacher, which may not allow for an accurate portrayal of the teachers' technology-enhanced creativity-fostering beliefs in action. Future studies may include longitudinal investigations to better document teachers' beliefs and experiences. Through using different data sources the study could yet provide an in-depth description of the phenomena. Also, data for the present study was drawn from teachers' self-reports and observation of practice. Future studies would benefit from incorporating students' perspectives on the role of technology to foster creativity as well as their perceptions of teachers' technology-enhanced creativity-fostering practices.

Finally, it is important to note that Study 2 makes no claims about the effectiveness of the technology-enhanced creativity-fostering practices reported or observed, rather it hopes to generate a range of technology-integrated instructional approaches and activities the effectiveness of which for creativity and learning could be explored and empirically tested. Thus, Study 2 provides future research with themes grounded in the realities of the classroom.

The next final Chapter 6 of the dissertation concludes the multimethod investigation presented in the dissertation by addressing overall implications, contributions, suggestions.

Chapter 6: Overall Conclusions

The goal of the current dissertation was to explore teachers' beliefs about and experience with nurturing student creativity in technology-integrated learning environments with the aim of generating themes and questions for future research on creativity, learning, and technology grounded in the realities of the classroom as well as to support policy, teacher education, and practice in the area of technology-enhanced creativity education. The dissertation adopted a qualitatively-driven sequential multimethod approach to research. First, a systematic literature review was conducted to determine teachers' beliefs about creativity and its nurture, with special focus to the perceived roles of technology in fostering creativity in the recent empirical research base (Study 1), then multiple case studies (Study 2) were carried to investigate educational technology expert secondary school teachers' beliefs about and experience with nurturing creativity in technology-integrated learning environments.

This final Chapter 6 concludes the multimethod investigation presented in the dissertation by addressing overall implications, contributions, as well as suggestions for future research. First, the study's implications for different stakeholders are outlined, such as educational policymakers, teacher educators, and teachers (Section 6.1). Second, the chapter concludes the main contributions of the current study to the existing literature (Section 6.2). The chapter ends with suggestions for future research, including some possible themes and research questions grounded in the realities of the classroom identified through this study (Section 6.3).

6.1 OVERALL IMPLICATIONS

The results of this qualitatively driven multimethod study have several implications which can help create opportunities to promote students' creativity across the curriculum in schools both in Hungary, and in other countries. These implications are assigned to different agents, namely policymakers, teacher educators, and teachers themselves.

6.1.1 Implications for policymakers

Three implications can be related to policymakers seeking to enhance educational policies and provide appropriate contexts for nurturing students' creativity with technology in K-12 education.

First, beyond establishing creativity as an outcome for students, **policy documents should include research-based definitions and conceptualizations of creativity across curricular areas and education levels** to increase teachers' understanding of the phenomena. Both Study 1 and Study 2 revealed that despite several common elements, teachers define creativity in various ways. Study 1 also highlighted that though educators from various settings and cultures generally value creativity and believe it can be nurtured, many of them also hold beliefs that could as act as barriers to fostering creativity in the classroom (i.e. some teachers believe that creativity means only originality, is relevant mainly for the arts, they might have limited views on creative student characteristics, and creativity-fostering pedagogies). Study 2 found that highly accomplished teachers' creativity-beliefs may be more aligned with the literature, still there are certain aspects of creative pedagogy in the understanding of which they need support (e.g. assessment). Offering a research-based definition and conceptualizations in policy documents as well as framing creative pedagogy in the curriculum in more detail could increase the likelihood that teachers develop more coherent and research-aligned views, which in turn might lead to more effective creativity-fostering practices, either with or without the use of technology.

Second, **policy documents should offer guidelines on how technology can promote creativity across the curriculum**. Study 1 highlighted that teachers may adopt various stances in relation to the role of technology in creativity viewing technological tools as enablers or barriers to students' creative development. In addition, though few studies explored teachers' beliefs about technology-supported creativity-enhancement in-depth, these suggest that educators in certain contexts may have vague ideas on how to promote creativity with technology across the curriculum. Weaving technology-enhanced creativity into the curriculum based on the theoretical frameworks provided by the literature and Study 2 could support teachers to enrich their pedagogical repertoire, and promote students' creative capacities with digital tools in a more conscious way.

Third, **education policy should address challenges and advance facilitators to promoting creativity in the classroom including those that are technology-related**.

Findings of both Study 1 and Study 2 revealed several barriers teachers perceive to promoting creativity which prevent them from translating their positive beliefs into creativity-fostering classroom practices in various ways. Study 1 showed that most widely cited barriers to nurturing creativity across studies and cultures were lack of time and training, inadequate resources, overloaded curriculum, standardized tests, and difficulties in assessing creativity. For Hungarian digital pedagogy expert teachers, the most agreed on constrains to technology-supported creativity-enhancement were packed and restrictive curricula, often discussed together with lack of time and final exam pressure, lack of student access to appropriate technology in schools, a creativity-stifling pedagogical culture, and students' creativity-related attitudes, values, and beliefs. Constrains mediate how teachers translate their creativity-fostering beliefs into classroom practices, thus educational policymakers should take into account teachers' points of views, and examine these factors.

6.1.2 Implications for teacher educators

Several implications can be derived from the current study that could be adopted by teacher educators within pre-service and in-service programs including the following.

First, **creativity should be included in teacher education curricula**. Findings in Study 1 suggest that teacher education should lay special emphasis on supporting teachers to conceptualize, recognize, explicitly teach for, and assess creativity across specific subject areas and grade levels, while Study 2 revealed that the assessment of creativity is a key area which should be specifically targeted in professional development. Training also needs to address teachers' creativity and technology beliefs by including opportunities for participants to make their beliefs explicit, and reflect on them in the light of new knowledge and experience gained.

Second, **teacher education should address the role of technology in promoting students' creativity**. Study 2 found that teachers had several ideas on how to promote creativity and implemented a range of technology-supported creativity-fostering activities, while other teachers in Study 1 had more limited views. These findings also suggest that teacher education should build on exemplary teachers' experience and involve them in the education of others.

Third, **teacher education should prepare educators to address barriers to fostering creativity and using technology, and help them develop mechanism to cope with constrains**. Infusing creativity into a packed curriculum, or addressing students' and parents' negative attitudes to creative education, as well as using mobile technologies to support creativity are some issues teacher educators might consider to tackle in professional development in the Hungarian context as suggested by Study. 2. Courses, training programmes, and workshops could also offer opportunities for participants to discuss constrains with each other and find creative strategies to confront these.

6.1.3 Implications for practice

This multimethod study has implications for the teachers who wish to promote their students' creativity in the classroom, and use technology in the process. **Teachers need to monitor their own beliefs and cultivate self-responsibility to acquire knowledge about creativity and its nurture**. Both Study 1 and Study 2 highlighted that educators might hold beliefs that act as barriers to fostering creativity in education, while Study 1 revealed that some have limited conceptions of creative pedagogies. Teachers could use current creativity research to inform their beliefs. In addition, self-directed learning from online resources and collaboration through digital tools enabled teachers in Study 2 to develop technology-supported creativity-fostering ideas for the classroom. Such forms of non-traditional professional development could play a key role in developing more effective classroom practices to promote creativity in education.

6.2 CONTRIBUTIONS OF THE STUDY

In addition to practical implications, the present multimethod study also contributed to existing literature in the following ways:

The study **contributed to a better understanding of teachers' beliefs about creativity and its nurture through technology by synthesizing the most rigorously available recent empirical evidence base**. Though a systematic review of teachers' beliefs about creativity has been carried out before (Andiliou & Murphy, 2010), more recent beliefs and those about nurturing creativity with technology have not been synthetized before.

The study **investigated highly accomplished teacher' beliefs and experience with nurturing creativity with technology for the first time in the literature**. Though highly accomplished teachers' beliefs about creativity (Henriksen & Mishra, 2015; Merriman 2015; Scott, 2015) and technology (Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010) have been explored separately before, the current study focused for the first time on exemplary teachers' beliefs and experience of nurturing creativity with technology. The study thus provides insights into what may work in the classroom in terms of fostering students' creativity with technology, informing research and practice about possible effective technology-enhanced creativity-fostering activities.

By identifying six types of technology-enhanced activities perceived as valuable digital pedagogy expert teachers for fostering creativity across the secondary curriculum, the study **established a new framework for technology-enhanced creativity fostering pedagogies grounded in the realities of the classroom**. In addition, the study identified several subject-specific creative activities with technology applied in the classroom, the effectiveness of which can be tested empirically by future research.

The study **provided a list of constraints and facilitating factors with respect to fostering students' creative capacities, and specifically to using technology in the process.** Study 1 first gathered facilitators and constrains to fostering creativity based on existing empirical evidence, while Study 2 provided a list of specific influencing factors associated with fostering creativity through technology in Hungary. Researchers can evaluate the transferability of the identified facilitators and constrains to other situation, times, and develop measures based on them.

The study **filled the gap in the Hungarian context by examining Hungarian teachers' beliefs about and experience with fostering creativity** and using technology in the process for the first time. Thus, the study contributed to the understanding of the relationship among creativity-related beliefs, practices, and influences within the Hungarian education system.

6.3 SUGGESTIONS FOR FUTURE RESEARCH

The multimethod study presented in this dissertation, being of an exploratory nature, raises a number of opportunities for future research at the intersections of creativity, technology, learning, and teachers' beliefs.

First, Study 1 showed that there are context-related variations in teachers' beliefs about creativity. Future studies could benefit from exploring the similarities and differences between teachers' beliefs in various settings, also other than cultural, through comparative studies and replications. Research in these areas would elucidate specific beliefs framed by the specific contexts in which teachers practice. Study 1 also found that various teacher groups hold different beliefs about the usefulness of technology to promote creativity. Findings showed that many teachers across the studies viewed technology as an important enabler or a serious barrier to creativity education in K-12 settings, while others had more balanced views. Future research could investigate teachers' value beliefs regarding the role of technology in creativity together with other potentially associated one's such as those about creativity, the role of technology in learning, and knowledge to explore underlying reasons. Such studies could inform interventions aimed at helping teachers develop more sophisticated beliefs about the relationships among creativity, technology, and learning.

Second, Study 1 revealed a concern for disruptive technologies impeding students' creativity in the classroom. The potential of technology to act as a barrier to creativity was also expressed by digital pedagogy exemplary teachers in Study 2. Educational research could investigate the effects of various levels of student access to technology in creative ideation or phases of creative production in K-12 settings to provide guidance for practice in this respect.

Third, Study 2 identified six types of technology-enhanced activities digital pedagogy expert teachers believed were valuable for fostering creativity across the secondary curriculum: igniting students' creative thinking with technology, developing and exploring ideas with technology, creating with technology, scaffolding student creativity with technology, augmenting collaboration with technology, communicating and evaluating creative outcomes with technology. In addition, Study 2 provided a numbers of domain specific creative activity examples based on digital-pedagogy expert teachers' view. These categories and examples could be used to develop scales to measure teachers' value beliefs about the role of technology in promoting creativity, and determine the relevance of the categories and activities identified for different grade levels and subject groups, and involving more traditional teacher populations.

Fourth, Study 2 offered a new framework for technology-enhanced creativity fostering pedagogies grounded in the realities of the classroom, and identified several

subject-specific creative activities with technology for future empirical investigations. Thus, possible future research suggested by Study 2, include, for example, the examination of the role of different types of digital resources (video, audio, multimedia, teacher created, student created) to engage students in creative thinking; the effectiveness of using simulations, knowledge engines, and microworlds during inquiry-based learning in the STEM areas, as well as of commercial history-related games on students' learning and creativity in these domains. In addition, longitudinal studies could explore the effects of producing various digital products highlighted by Study 2 on students' learning as well as on their digital and domain-specific creativity. Future studies could also investigate the feasibility of promoting creativity through blended environments in K-12 settings, and the effects of diverse purposes and audiences enabled by technology on students' creative production and learning.

Fifth, Study 1 and Study 2 identified several barriers and enablers to nurturing creativity, and specifically to nurturing it with technology. Future studies could determine how the influences identified apply to other teachers' contexts and settings as well as explore the relationships between influencing factors.

Finally, it was evident that there was a serious lack of research on teachers' beliefs about and experience of nurturing creativity, either with or without the use of technology in the Hungarian context. Future studies could adopt both qualitative research and explore the rich data from it, and use statistical measurements and analyses to refine and further elaborate the novel findings in the present study.

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Appendices

Appendix A

Appendix A. Scoring sheet for assessing 'weight of evidence' based on the WoE framework

Type of WoE	Criteria	3 fully met	2 mostly met	1 met to some extent	0 not at all met
WoE A: Methodological quality	The aims and objectives of the research clearly stated.				
	The conceptual framing of the study is adequate and clearly described.				
	The study design is appropriate to the research questions.				
	The context of the study is clearly described.				
	The sampling strategy is adequate and clearly described.				
	Data collection is adequate and clearly described.				
	Data analysis is adequate and clearly described				
	Findings are supported by data.				
	Claims rest on findings.				
	Methodological quality score: /27. p				
	The methodological quality of the study is sound. (Consider: 22-27 for fully met, 16-21 for mostly met, 9-15 for met to some extent)				
WoE B: Methodological relevance	The study design chosen is adequate to determine in-service K12 views about creativity.				
WoE C: Topic relevance	The study provides sufficient and adequate findings on in-service K12 teachers' views about creativity.				
Overall WoE D (circle appropriate):		**high**	**medium**	**low**	**inade-quate**

Appendix B

Appendix B. The 'weight of evidence' of the included studies

Authors	WoE: A	WoE: B	WoE: C	Overall
Al-Nouh, Abdul-Kareem, & Taqi (2014)	high	high	high	high
Beghetto, Kaufman, & Baxter (2011)	high	high	high	high
Chan & Yuen (2014)	high	high	medium	high
Gralewski & Karwowski (2013)	high	high	high	high
Hartley, Plucker, & Long in Hartley (2015) A	high	high	high	high
Karwowski (2010)	high	high	high	high
Leikin et al. (2013)	high	medium	high	high
Shen (2014)	high	high	medium	high
Zhou et al. (2013)	high	medium	high	high
Adams (2013)	medium	medium	low	medium
Aish (2013)	high	medium	medium	medium
AlKhars (2013)	high	medium	medium	medium
Alsahou (2015)	high	medium	low	medium
Bryant (2014)	high	medium	low	medium
Cachia & Ferrari (2010)	medium	medium	medium	medium
Cheng (2010)	high	medium	medium	medium
Daskolia, Dimos, & Kampylis (2011)	high	medium	medium	medium
DaVia Rubenstein, McCoach, & Siegle (2013)	high	medium	low	medium
Dickman (2014)	medium	medium	low	medium
Fairfield (2010)	medium	medium	medium	medium
Frawley (2014)	high	medium	low	medium
Hartley & Plucker (2014)	high	medium	medium	medium
Hartley, Plucker, & Long in Hartley (2015) B	high	medium	medium	medium
Henriksen & Mishra (2015)	high	medium	low	medium
Hoff & Carlsson (2011)	medium	medium	medium	medium
Hondzel (2013)	medium	high	low	medium
Hong & Kang (2010)	high	medium	medium	medium
Huang & Lee (2015)	medium	medium	medium	medium
Konstantinidou et al. (2013)	medium	low	high	medium
Konstantinidou et al. (2014)	medium	low	high	medium
Lasky & Yoon (2011)	medium	medium	low	medium
Lev-Zamir & Leikin (2011)	high	high	low	medium
Lev-Zamir & Leikin (2013)	high	high	low	medium
Levenson (2013)	high	medium	medium	medium
Levenson (2015)	medium	high	low	medium
Liu & Lin (2014)	high	medium	low	medium
McLellan & Nicholl (2013)	high	high	low	medium
Merriman (2015)	high	medium	low	medium
Meyer & Lederman (2013)	medium	medium	low	medium
Myhill & Wilson (2013)	high	medium	low	medium
Newton & Newton (2010)	high	medium	low	medium
Olivant (2015)	medium	medium	low	medium
Scott (2015)	high	medium	medium	medium
Shaheen (2011)	high	medium	medium	medium
Snell (2012)	medium	medium	low	medium
Stone (2015)	medium	medium	medium	medium
Tanggaard (2011)	medium	medium	low	medium
Tomasevic & Trivic (2014)	high	low	medium	medium
Turner (2013)	medium	high	low	medium
Urhahne (2011)	medium	high	medium	medium
Zbainos & Anastasopoulou (2012)	medium	low	medium	medium
Kampylis, Saarilouma, & Berki (2011)	medium	low	low	low
Pavlović, Maksić & Bodroža (2013)	medium	low	low	low

Appendix C

Appendix C. Pre-observation interview

(Translated from Hungarian)

PLACE AND TIME: _____

TEACHER'S PSEUDONYM: _____

Questions	Notes
1. What is the main topic of the class period? *2. What will students learn during the class period? What are the learning objectives?* *3. What are the main parts of the class period? Please describe briefly what will happen during each part!* *4. How will this class period promote students' creativity?* *5. What kind of digital and non-digital tools and materials will be used during the class?* *6. How will the digital and non-digital tools and materials promote students' creativity?*	

Thank you very much for the interview!

Appendix D

Appendix D. Classroom observation sheet

Date of observation: _____Duration: _____

Teacher (pseudonym): _____

Subject area: _____ Grade level: _____

Class size: ____, Female: ____, Male: ____ Seating plan: rows ____ groups ___, circle ___

Technology available in the classroom _____

_____

_____

_____

Lesson plan available for analysis: yes _____, no _____

Topic of the class:	**Learning objectives:**

Lesson stages:

The class promotes creativity, because (teacher's view):

Digital and non-digital tools and materials used:	Digital and non-digital tools and materials used to promote student creativity:

Time	Observations	Notes

Appendix E

Appendix E. Post-observation interview protocol
(Translated from Hungarian)

PLACE AND TIME: _____

TEACHER'S PSEUDONYM: _____

Questions	Notes
I. The nature of creativity	
1. What comes to your mind when you hear the word creativity? How would you define creativity? *2. How would you describe the relationship between creativity and your own subject?* Probing questions: What does creativity mean in your own subject? How important is it? Why? Are there any school subjects in which creativity is more relevant? Please, explain your thoughts! *3. What differences do you see between primary and secondary school students' creativity in your curricular area?* Probing questions: Could you share your view on differences in terms of students' age/ knowledge and skills/ personal characteristics? *4. How would you describe a creative student?* Probing questions: How would you describe a creative student in your class? What characterizes creative students in terms of traits, skills, knowledge? *5. What constitutes a creative outcome?* Probing questions: What characteristics do creative products have? Who judges them? On what grounds?	
II. Nurturing creativity with technology	
1. Can creativity can be enhanced? Probing questions: Can all students be creative? Is creativity inborn or can it be learnt? 2. *Can creativity be assessed?* Probing questions: How can creativity be assessed? How is creativity assessed in your classroom?	

3. How can creativity be fostered in your subject area? Probing questions: What is the relationship between learning and creativity? What strategies do you use to foster students' creativity? What characterizes a creativity-fostering learning environment? *4. How is technology useful in nurturing secondary students' creativity in your subject area?* Probing question: Could you please give examples of activities that you have implemented to promote students' creativity with digital technology? *5. What do you see as the role of technology in the assessment or measurement of creativity in education?* Probing question: Could you give some examples in which technology has played a role in assessing creativity in your classroom?	
III. Enablers of and barriers to nurturing creativity with technology	
1. What do you see as barriers to fostering creativity in your classroom? Probing question: Are there any technology-related barriers? *2. What helps you fostering creativity in your classroom* Probing question: Are there any technology-related facilitators? *3. Is there anything I haven't asked you about that you would like to discuss?*	

Thank you very much for the interview!

Appendix F

Appendix F. Teacher demographic questionnaire
(Translated from Hungarian)

The purpose of this study is to explore the role of technology in learning and creativity. Your thoughts and ideas will help us gain a better understanding on how creativity is promoted through technology in the high school classroom. Your answers will be used for academic purposes only. Your identities will be anonymous. Your answers will be confidential.

Please, fill in the blanks or underline the appropriate answer!

1. Age: _____

2. Educational background:

BA in: _____

MA in: _____

PhD in: _____

3. What is your current teacher career stage?

Teacher 1 Teacher 2 Master teacher

4. What subjects do you teach? _____

5. What grade levels do you teach? _____

6. Type of school, where you teach: _____

7. How many years have you taught?

1-5 years 6-10 years 11-20 years 21-30 years more, than 31 years

8. Have you ever had a course on creativity at college or university?

Yes No

9. Have you ever participated in a lecture/workshop/training on creativity?

Yes No

10. Have you ever held a lecture/workshop/training course on creativity?
Yes No

11. With whom have you shared your ideas and/or classroom experience and/or good practices in the area of promoting student creativity?

nobody
my colleagues from school
undergraduate and/or graduate students
teachers from other Hungarian schools, Hungarian experts
teachers and/or experts from other countries

12. Have you ever had a course on teaching and learning with technology at college or university?
Yes No

13. Have you ever participated in PD (lecture, workshop, training course) on teaching and learning with technology?
Yes No

14. Have you ever held a lecture/workshop/training course on teaching and learning with technology?
Yes No

15. With whom have you shared your ideas and/or classroom experience and/or good practices in the area of teaching and learning with technology?

nobody
my colleagues from school
undergraduate and/or graduate students
teachers from other Hungarian schools, Hungarian experts
teachers and/or experts from other countries

16. Please, list any honours, awards, or other recognition of your work as a teacher that you have received in your career!

Thank you for taking part in this study!

Appendix G

Appendix G. Coding analysis of the interview transcripts with reference to teachers' beliefs about creativity

Category	Theme	Subtheme	Nr. of resp.	Comment frequency by respondents												Total com.
				ART1	ART2	EFL1	EFL2	HUN1	HUN2	MAT1	MAT2	SC I1	SC I2	SOC1	SOC2	
DEFINITION	Means originality		**12**	1	2	2	1	1	3	2	1	2	1	2	2	**20**
	Means appropriateness		**12**	1	2	2	1	1	2	1	1	1	1	1	2	**15**
	Requires certain personal characteristics	*Curiosity*	**9**	0	2	2	1	1	0	2	1	1	1	1	0	**12**
		Know-ledge	**7**	2	2	0	1	0	0	0	2	0	1	2	1	**11**
		Hard work and commit-ment	**7**	0	1	1	0	0	2	2	0	2	1	1	0	**10**
		Risk-taking	**7**	0	1	1	1	1	0	1	0	0	1	0	1	**7**
		Intrinsic motivation	**5**	1	1	0	0	0	0	0	1	0	0	1	1	**5**
	Requires certain environmental conditions	*Idea time*	**11**	1	2	2	1	0	1	1	1	1	1	2	2	**28**
		Safety and trust	**6**	0	0	5	1	2	0	0	3	3	0	0	2	**16**
		Freedom	**9**	1	1	2	1	3	1	1	1	0	1	0	0	**12**
		Constrains	**6**	0	1	3	1	2	1	0	0	0	1	0	0	**9**
SPECIFICITY	Easy to find in the art-related subjects		**6**	1	0	2	0	1	0	0	1	1	0	0	1	**7**
	Relevant in all curricular areas		**12**	1	3	2	2	2	1	1	1	4	2	2	1	**22**
	Specific to each curricular area (problem-solving, self-expression, way of thinking)		**12**	4	1	4	2	7	7	6	9	6	2	2	4	**54**
	Multiple creativities in classes (e.g. scientific, artistic, language)		**6**	1	0	0	1	1	0	0	0	3	1	1	0	**8**
	Changes across education levels		**10**	2	0	2	0	3	6	3	1	6	7	2	3	**35**
MALLEABILITY	Can be nurtured		**12**	1	1	1	1	1	1	1	2	1	1	1	1	**13**
	Is difficult to assess		**6**	0	0	1	1	3	2	2	0	0	0	1	0	**10**
	Respondents comments total			**15**	**25**	**30**	**16**	**28**	**27**	**23**	**24**	**31**	**23**	**23**	**19**	**284**

Appendix H

Appendix H. Coding analysis of the interview transcripts with reference to teachers' beliefs about nurturing creativity with technology

Theme	Nr. of resp.	Comment frequency by respondents												Total com.
		ART1	ART2	EFL1	EFL2	HUN1	HUN2	MAT1	MAT2	SCI1	SCI2	SOC1	SOC2	
Igniting creativity with technology	**8**	1	1	4	0	1	0	1	0	0	1	3	1	**13**
Developing ideas with technology	**8**	0	1	0	0	2	0	2	2	7	6	1	1	**22**
Creating with technology	**11**	2	7	4	3	6	14	0	3	9	1	3	4	**56**
Collaborating with technology	**8**	0	2	1	1	1	2	0	1	1	0	0	3	**12**
Scaffolding creativity with technology	**10**	1	2	3	2	0	2	1	1	5	1	0	1	**19**
Communicating and evaluating creativity with technology	**9**	2	2	3	1	3	6	0	2	2	0	0	3	**24**
Respondents comments total		**6**	**15**	**15**	**7**	**13**	**24**	**4**	**9**	**24**	**9**	**7**	**13**	**146**

Appendix I

Appendix I. The distribution of instructional strategy codes technology-enhanced creativity fostering activities in the interviews

Instructional strategy	**Comment frequency by technology-enhanced creativity-fostering activities**						**Total strategies**
	Igniting creative thinking	Developing ideas	Creating	Collaborating	Scaffolding creativity	Communicating outcomes	
Dialogue	9	1	2	0	3	0	**17**
Lecture	1	0	0	0	0	0	**1**
Project work	1	1	19	6	5	8	**40**
Project-based learning	0	1	24		7	13	**45**
Inquiry-based learning	2	16	1	0	2	1	**22**
Practice-based learning	0	1	5	6	2	2	**16**
Problem-based learning	0	2	3	0	0	0	**5**
Design-based learning	0	0	1	0	0	0	**1**
Total type of activities	**13**	**22**	**54**	**12**	**19**	**24**	**146**

Appendix J

Appendix J. Coding analysis of the interview transcripts with reference to the perceived barriers and enablers of nurturing creativity with technology

Category	Theme	Subtheme	Nr. resp.	Comment frequency by respondents												Totals
				ART1	ART2	EFL 1	EFL 2	HUN1	HUN2	MAT1	MAT2	SCI1	SCI2	SOC1	SOC2	
BARRIERS	System-related	Curriculum: packed, restrictive	10	3	2	0	0	1	1	1	1	1	2	5	1	18
		System Lack of time	9	1	7	0	0	0	0	1	1	2	3	6	1	22
		Final exam pressure and standardized assessment	7	1	1	1	0	0	0	2	3	0	0	2	2	12
		Large class size	5	1	2	0	0	0	2	0	0	0	1	2	0	8
		Heavy teacher workload	5	0	1	0	0	1	0	0	0	0	2	1	1	6
		Inadequate professional development courses	4	1	1	0	0	0	1	0	0	0	1	0	0	4
	Culture-related	Creativity-stifling pedagogical culture	10	1	1	2	0	2	0	1	1	2	1	2	2	15
	Technology-related	Access: Limited in school	9	2	2	0	1	2	2	0	3	2	2	2	0	18
		Connectivity: Bad or no Internet connection	5	0	1	0	1	1	0	0	0	1	2	0	0	6
		Usability: Outdated, incompatible, unreliable technology	7	2	1	0	1	0	0	0	2	1	2	0	3	12
	Other resource-related	Inadequate resources (scheduling, physical environment, teaching materials)	6	1	0	0	1	2	1	0	1	0	1	0	0	7
	Interpersonal	Students' attitude to creativity in education	8	0	2	2	2	2	0	1	1	0	1	6	0	17
		Parents' attitude to creativity in education	4	0	1	0	0	0	0	0	1	0	1	1	0	4
	Personal	Teachers' insecurity about nurturing creativity with technology	3	0	1	0	0	1	0	1		0	0		0	3
		Teachers' insecurity about nurturing and assessing creativity	2	0	0	0	0	2	1	0	0	0	0	0	0	3
	Total barriers		**94**	**13**	**23**	**5**	**6**	**14**	**8**	**7**	**14**	**9**	**19**	**27**	**10**	**155**
ENABLERS	System-related	Non-traditional PD: self-directed, collaborative, practice-based	6	0	1	1	0	0	3	0	1	5	4	0	0	15
		Some freedom in the curriculum	4	0	0	2	1	0	1	0	1	0	0	0	0	5
		Small class size in some contexts	3	1	0	1	0	0	0	0	0	0	1	0	0	3
		Creativity valued in the final exam	2	0	0	1	0	0	0	0	0	0	2	0	0	3
	Culture-related	Changing pedagogical culture	3	0	0	0	0	0	0	1	1	0	1	0	0	3
	Technology-related	Access: Students' mobile devices	10	2	3	4	1	1	0	0	2	2	2	0	1	18
		Access: Students' home devices	6	1	0	0	2	0	2	0	1	1	1	0	0	8
	Interpersonal	Students' positive attitudes to technology-enhanced learning	7	1	2	1	0	1	1	0	0	0	0	1	2	9
		Students' positive attitudes to creative activities	6	1	0	0	0	2	3	0	1	1	0	1	0	9
	Personal	Teachers' willingness to bend rules	5	0	0	0	0	1	1	1	0	2	0	2	0	7
		Teachers' own creativity	3	1	0	0	0	0	0	0	0	0	1	0	1	3
		Teachers' feeling of appreciation	3	1	0	0	0	0	1	0	0	0	0	0	1	3
	Total enablers		**58**	**8**	**6**	**10**	**4**	**5**	**12**	**2**	**7**	**11**	**12**	**4**	**5**	**86**