In search of virtuous learning circles: absorptive capacity and its antecedents in the education sector

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Abstract

Purpose – *This study aims to identify context-specific antecedents to schools' absorptive capacity (AC) and to show how those can enact "a virtuous learning circle."*

Design/methodology/approach – *The study uses a mixed method: an exploration based on semi-structured interviews with educational experts; the development of a measurement scale and a partial least squares structural equation modelling to test the impact of the antecedents.*

Findings – *The results yielded four empirically-grounded antecedents and their measurement scales, namely, prior knowledge, employees' skills, educational projects and interactions with the environment (Studies one and two). All antecedents are significantly and positively related to AC processes (study three). Using the organizational learning theory perspective, the results have been interpreted as an AC "virtuous learning circle."*

Practical implications – *With increasing pressures to adapt, a case of which was the COVID-19 pandemic, schools can greatly benefit from absorbing knowledge flows. This suggests the construction a favourable environment for AC. To this end, the individual (employees' prior knowledge and skills), organizational (educational projects) and institutional level of managerial action (interactions with the environment) can be effective when create a recursive organizational learning circle. In addition, this study offers an expert-validated measurement scale for self-assessment of a school's specific contingencies, and thus, for planning of punctual interventions to develop AC.*

Originality/value – *This study advances the existing body of knowledge management in the educational context by rigorously identifying and validating a scale for measuring the antecedents of AC and developing an interpretive approach to the AC "virtuous circle."*

Keywords *Absorptive capacity, Antecedent, Organizational learning theory, Virtuous learning circle, Educational sector*

Paper type *Research paper*

1. Introduction

Like any other organization, modern schools are challenged by pressures on efficiency, effectiveness and responsiveness (Schleicher, 2015), and therefore, concentrating on knowledge management becomes paramount as it is one of the dominant sources of competitive advantage (Harris and Jones, 2018; Stoll and Kools, 2017). A growing number of studies argue that schools thrive when they are able to acquire new knowledge, especially through their teaching staff and assimilate it into the school's consolidated processes (Zuckerman *et al.*, 2018). For example, the Organization for Economic Cooperation and Development (OECD) encourages schools to acquire and use knowledge to deal with changing environments. This facilitates and sustains organizational changes and innovations (Kools *et al.*, 2020; Roberts *et al.*, 2012; Zuckerman *et al.*, 2018), better identify and satisfy students' and stakeholders needs (Da'as and Qadach, 2018), activate learning loops (Harris and Jones, 2018) and finally, improve performance (Berson *et al.*, 2015).

Thus, to improve effectiveness in a rapidly changing environment (Fullan and Quinn, 2016; Schleicher, 2012), schools need to improve their organizational learning processes.

The COVID-19 pandemic adds to the urgency to quickly and comprehensively adapt to a completely different environment (Longhurst *et al.*, 2020). The pandemic has affected the way education is delivered around the world. Lockdowns have led to changes in the structures and processes that schools operate under and have forced them to shift to online learning as a replacement for on-site delivery. According to the OECD (2020), COVID-19 has exposed many inadequacies in the functioning of schools, especially misalignment between resources and needs. Thus, the COVID-19 pandemic has only hastened an inevitable process of profound renewal in schools.

By recognizing and gaining external knowledge and assimilating and applying it to organizational processes, adaptation to challenging environments can be more effective and faster (Chu, 2016; Massaro *et al.*, 2015). The concept of absorptive capacity (AC) captures an organization's ability to benefit from external knowledge through exploratory, transformative and exploitative learning processes (Cohen and Levinthal, 1990). However, developing AC is not an effortless endeavour, especially under high resource allocation demands (Volberda *et al.*, 2010). Hence, it is important to understand the elements relevant to AC development. These elements are traditionally called antecedents as they "refer to a chronological and logical precedence of a premise before an outcome, thus capturing two important features: directionality of association and causality" (Czakon *et al.*, 2020). The vast stream of research into AC antecedents focuses on business organizations e.g. pharmaceutics (Rafique *et al.*, 2018), technology-intensive (Stulova and Rungi, 2017), manufacturing (Guedes *et al.*, 2017), banking (Pennings and Harianto, 1992), construction (Gann, 2001), small enterprises (Gray, 2006), international corporations (Grünfeld, 2006), chemical products and food processing (Caloghirou *et al.*, 2004) and health care (Caccia-Brava *et al.*, 2006; Knudsen and Roman, 2004).

Understanding AC and its antecedents in school settings means better understanding how schools can benefit from external knowledge sources for learning and knowledge management. AC in schools has been individuated as a key driver of change and innovation (Kools *et al.*, 2020), a condition for school learning (Harris and Jones, 2018) and a coping mechanism with grand societal and environmental challenges (Caiazza *et al.*, 2021). Besides, any change can destabilize the existing equilibrium and AC helps to identify opportunities and to recognize the value in crisis situations, including the COVID-19 pandemic (Caiazza *et al.*, 2021). Consequently, school leadership should ensure that their processes and activities are geared towards maximizing the value of their resources so as to develop AC (Da'as and Qadach, 2019). For all these reasons, the concept of AC has now become more important than ever, also for schools.

The list of possible antecedents of AC is quite substantial, but they also seem to be context-bound and so their relative importance is uncertain (Rezaei-Zadeh and Darwish, 2016; Volberda *et al.*, 2010). The AC concept has received attention in the educational context only in recent time (Farrell *et al.*, 2019; Zuckerman *et al.*, 2018) and knowledge about its antecedents is still scarce (Deschesnes *et al.*, 2013; Da'as and Qadach, 2018; Farrell *et al.*, 2019; Zuckerman *et al.*, 2018). Explorative evidence has been provided, but more should be done to understand the specific role of various AC antecedents and their actual impact. Prior studies are based mainly on qualitative research and address selected antecedents of AC, for example, educational projects (Deschesnes *et al.*, 2013; Fernández and Brito, 2019), communication pathways, partner resources (Farrell and Coburn, 2017) and leadership (Farrell and Coburn, 2017; Da'as and Qadach, 2018; Zuckerman *et al.*, 2018). Additionally, in spite of researchers' growing interest in AC in schools, developing a measurement scale for AC in the educational field is eagerly awaited (Da'as and Qadach, 2018). Firstly, "most studies have operationalized absorptive capacity with research and development-related proxies, such as R&D intensity or patents [. . .] leading us to question

whether these studies actually measured absorptive capacity at all" (Lane *et al.*, 2006, p. 854). Secondly, existing measurement methods have been developed for large organizations (Noblet *et al.*, 2011). Finally, Da'as and Qadach (2018) proposed the creation of new measurements for the AC construct applied to the educational system. However, these self-reporting questionnaires were reserved for teachers and some authors suggested that school management was critical in the development of AC (Kools *et al.*, 2019; Sun and Gao, 2019).

To address the above-mentioned calls and advance the understanding of the issue, the aim of this paper is to identify antecedents to AC in schools that provide "a virtuous learning circle" so as to interpret its development. In addition, another objective is to develop a measurement instrument for AC and its antecedents. The following research questions guide this research questions (RQs):

RQ1. What are the most influential antecedents in developing AC in educational settings?

RQ2. How can AC (its antecedents and dimensions) be measured in the educational setting?

RQ3. Of these antecedents, which are positively related to the development of AC in schools?

To address our RQs, we have adopted the organizational learning theory perspective with specific consideration for double-loop learning (Argyris and Schön, 1996). We opted for this approach as it entails modification of goals and decision-making rules in the light of past experience (Argyris and Schon, 1978; Daghfous, 2004). This creates a self-propagating and complex chain of events with positive consequences at each subsequent stage and level of analysis. This approach seems appropriate for organizations operating in volatile and uncertain environments, such as schools (Castaneda *et al.*, 2018).

To test hypotheses, we used mixed-method design including interviews and a quantitative survey (Hendren *et al.*, 2018). We agree that mixed methods "provide a better understanding of research problems than either [the quantitative or qualitative] approach alone" (Creswell and Plano, 2007, p. 5). Indeed, epistemologically and methodologically speaking, educational research should promote pluralism (Johnson and Onwuegbuzie, 2004). That is why, to answer the first question, we conducted 30 semi-structured interviews with school principals. In this way, we managed to develop an empirically-grounded set of antecedents to AC in the context of schools. Next, to answer the second research question, we instructed a multi-step protocol consisting in a triangulation of qualitative data extracted from semi-structured interviews with school principals and teachers. This led to the development and the rigorously validation of our proposed measurement scale for AC and the antecedents to AC in schools. Finally, to answer the last research question, we conducted research by means of the questionnaire sent to the school Headmaster/mistress in Poland.

Our study contributes to AC literature in several ways. Firstly, a clear set of AC antecedents is still missing in the educational setting (Farrell *et al.*, 2019). This is something somehow missing, and therefore, the present study expands current knowledge on AC antecedents, especially considering their contextual nature (Rezaei-Zadeh and Darwish, 2016). Specifically, influential AC antecedents result to be: employees' prior knowledge and skills, educational projects and interactions with the environment. Secondly, the relevant literature posits that the development of a solid AC measurement tool poses a great challenge (Sedoglavich *et al.*, 2015). Therefore, we have developed a survey instrument to measure self-reported perceptions of school principals in relation to AC and its antecedents. This provides some fodder for developing specific hypotheses for the quantitative study (Walker and Baxter, 2019). Thirdly, we tested significant relationships on the pre-specified constructs to validate the theory. Overall, our contributions can be interpreted in a model that we termed the AC "virtuous learning circle;" the model develops on three levels, i.e.

individual, organizational and institutional one and it is recursive and can self-propagate, accumulating incremental positive benefits when proper organizational learning routines are in place (Marabelli and Newell, 2009). Success is improved by the antecedents and this leads to organizational learning (Ferreira *et al.*, 2020). However, as AC refers to acquisition, assimilation, transformation and exploitation of external knowledge (Zahra and George, 2002), in its operative aspects it closely relates to knowledge management (Sun and Anderson, 2010). For this reason, our findings also strengthen the literature on knowledge management in the school context (Chu, 2016).

Finally, in terms of practical implications, our study offers a set of recommendations for school management and leadership on how to manage each element. Best practices are presented in relation to the following: the individual level, i.e. how to stimulate employees' prior knowledge and skills and activate knowledge sharing processes; the organizational level, i.e. how to effectively lead engaging educational projects and the institutional level, i.e. how to deal with external knowledge, stakeholders and the environment as a whole. This complete system should be also considered as recursive in that it can activate organizational learning circles. In addition, our study offers an expert-validated measurement scale which is a practical tool available for principals to self-assess the specific contingencies faced by their school. This will help management in planning timely interventions to develop AC.

The manuscript is organized as follows: Section 2 develops the conceptual background; Section 3 describes the research objectives and presents the results of the qualitative approach (Studies 1 and 2). Section 4 summarizes the results of the quantitative test (Study 3), while Section 5 discusses its main findings. Finally, Section 6 concludes by outlining the theoretical and practical implications, as well as the potential limitations.

2. Conceptual background

2.1 Absorptive capacity

AC was first defined by Cohen and Levinthal (1990) as the organizational ability to value, acquire, assimilate and exploit external knowledge to achieve organizational outcomes. On the other hand, the existing literature assumes AC as a dynamic capability that focuses on organizational routines to deal with environmental turbulence or learning processes. In this context, AC is defined as "a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability" (Zahra and George, 2002, p. 186).

More in detail, AC processes are:

- acquisition, i.e. how organizations identify and acquire knowledge;
- assimilation, i.e. how organizations can absorb, understand, analyse, process and interpret this new external knowledge;
- transformation, i.e. development of procedures to merge the new knowledge acquired with the knowledge that already exists in the organizations; and
- exploitation, i.e. the process through which organizations apply this newly developed information to achieve their objectives (Zahra and George, 2002).

Thus, although AC is largely used in the strategic management domain, its operative aspects can be fully ascribed to a knowledge processing phenomenon. Taking these four dimensions together, AC is apt to change and reconfigure organizational routines and resources.

Recently, the AC concept has received major attention in the organizational context (Mariano and Walter, 2015; Ramachandran, 2018; Sadeghi *et al.*, 2021; Wang and Han, 2011). AC is

associated with several outcomes: innovation generally speaking (Wang and Han, 2011; Pangarso *et al.*, 2020; Limaj and Bernroider, 2019; Adriansyah and Afiff, 2015; Leal-Rodríguez *et al.*, 2014) and related concepts such as: innovative capability (Ávila, 2021), innovation performance (Wang and Han, 2011), open innovation (Lowik *et al.*, 2017; Wang *et al.*, 2017), co-innovation (Arias-Pérez *et al.*, 2020), external orientations such as interpretation of dynamic marketplaces (Greenhill and Oppenheim, 2017), disaster immunity (Sadeghi *et al.*, 2021), entrepreneurial orientation (García-Villaverde *et al.*, 2018), value creation (Campos-Climent and Sanchis-Palacio, 2017) and finally, knowledge management, either considered as a whole (Gray, 2006; Valentim *et al.*, 2016), or in its specific processes such as sharing and spreading knowledge within an organization (Gupta and Govindarajan, 2000), knowledge transfer (Tho, 2017), or creation (Mariano and Walter, 2015) and organizational unlearning (Ng and Sanchez-Aragon, 2021). In addition, AC has also been related to the achievement of an overall competitive advantage (Medase and Barasa, 2019; Zou *et al.*, 2018).

2.2 Absorptive capacity and organizational learning theory

Organizational learning is related to the development of new knowledge based on actions and behaviours in the organization and previous experiences. This leads to, among other things, the generation of new ideas and the detection and correction of errors (Del Giudice *et al.*, 2014; Huber, 1991; Scuotto *et al.*, 2017a, 2017b; Slater and Narver, 1995).

AC is associated with organizational learning (Cohen and Levinthal, 1990; Lane *et al.*, 2001, 2006; Lyles and Salk, 1996; Tu *et al.*, 2006), as a facilitator (Fosfuri and Tribó, 2008) and an accelerator (Schilling, 2002). These considerations are also valid for educational settings, thus how schools learn (Tichnor-Wagner *et al.*, 2016; Fullan, 2018; Giles and Hargreaves, 2006; Silins and Mulford, 2004). Indeed, schools are encouraged to become "learning organizations," thus "dealing with changing external environments, facilitating and sustaining organizational change and innovation and even improving student and human resources outcomes" (Kools *et al.*, 2020, p. 25).

The status of a "learning organization" cannot only be achieved by generating new knowledge (Vera *et al.*, 2015). A truly learning organization judiciously applies new knowledge by adapting internal knowledge at multiple levels. This occurs when members of the organization challenge procedures and policies in use and develop new ways of working.

Organizational learning theory outlines single and double loop learning modes (Argyris and Schön, 1996). Single-loop learning is a type of learning that fits prior experiences and existing values. Double-loop learning is learning that does not fit the learner's prior experiences and requires learners to change their mental schema in a fundamental way. Double-loop learning entails modification of goals or decision-making rules in the light of experience so as to achieve better outcomes (Argyris and Schön, 1996).

Initially, AC was recognized as representing a single-loop learning (Cohen and Levinthal, 1990). However, researchers also postulate that AC is an iterative process of exchange with a modifying assumption (Dyer and Singh, 1998; Lane and Lubatkin, 1998; Marabelli and Newell, 2009), thus, representing double-loop learning. Vera *et al.* (2015) suggested that "absorptive capacity was a subset of organizational learning because it focused on the value and assimilation of one specific type of learning: learning from external sources" (Vera *et al.*, 2015, p. 20). Following the organizational learning approach, we view AC as double loop process that involve recognizing new knowledge while continuing to use existing assimilated knowledge. Over time, organizations learn to learn and adapt to "modification of an organization's underlying norms, policies and objectives" (Argyris and Schon, 1978, p. 2–3). Garud *et al.* (2008) suggested that double loop learning could have an important bearing on whether or not organizations are able to harness knowledge systems in a virtuous knowledge circle. A virtuous cycle refers to intensive learning during which AC

leads to integrated actions and investments that produce significant learning effects (Garud *et al.*, 2008).

More generally, virtuous circles are self-propagating complex chains of events with positive consequences at one stage and generating increasingly greater positive consequences at each subsequent stage. The primary driver of AC is the organizational need to absorb and use new information, often in contradiction to long-established organizational knowledge and traditions, where these processes are practiced as a part of a virtuous circle. These primary drivers of AC are necessary to generate a virtuous knowledge circle. An additional requirement refers to coupling knowledge processes across different levels to jumpstart the establishment of a knowledge commons (Lowik *et al.*, 2017).

2.3 Antecedents to absorptive capacity

Previous literature identified a wide range of AC antecedents in different industry sectors and business cultures, both of an internal and external nature (Noblet *et al.*, 2011). For example, Daghfous (2004) outlined several antecedents to AC:

- Internal – including prior knowledge base, individual AC and the diversity of academic backgrounds, organizational structures and cultures.
- External – including the nature of external knowledge and the organization's position within the relevant knowledge network.

Meanwhile, Lowik *et al.* (2017) selected only three antecedents, namely, human capital, social capital and cognition. More generally, Volberda *et al.* (2010) organized the antecedents to AC by the level of analysis: managerial, intra-organizational and inter-organizational. Managerial antecedents include managers' combinative capabilities and cognitive processes. Intra-organizational antecedents include cross-functional interfaces, participation, job rotation, socialization capabilities and training. Finally, inter-organizational antecedents of AC may include diversity and complementarity of external knowledge sources (Zou *et al.*, 2018).

However, the same literature considers that AC antecedents need to be grounded in a specific organizational context (Tichnor-Wagner *et al.*, 2016), or at least within an industry (Rezaei-Zadeh and Darwish, 2016). For this reason, some antecedents may be less prominent than others, especially for the educational context. For example, R&D expenditure influences the development of AC (Cohen and Levinthal, 1990). However, in the educational context R&D is usually limited by state budgets and is difficult to identify. A similar conclusion can be drawn for the organizational structure that influences patterns and the frequency of communication and decision-making (Ali *et al.*, 2018). Again, for schools, the organizational structure is imposed by national regulations or educational districts. For all these reasons, it is necessary to pay most attention to context-specific elements rather than use an indiscriminate approach to AC antecedents (Rezaei-Zadeh and Darwish, 2016).

2.4 Educational settings and absorptive capacity

Recent AC studies have examined the educational context from various perspectives. Prior research largely focused on process and construct operationalization, with less attention paid to antecedents (Da'as and Qadach, 2018). For example, Deschesnes *et al.* (2013) explored the relationship between AC and innovation in two Canadian secondary schools. However, considering the antecedents to AC in particular, the promotion of educational projects seems a relevant aspect (Deschesnes *et al.*, 2013). In this line of enquiry, Fernández and Brito (2019) suggested that educational projects nourish the knowledge base of schools and provide the ability for them to combine action and knowledge production processes. This research was carried out under the principles of ethnographic

research and covers primary schools in France. Farrell and Coburn (2017) conducted a longitudinal comparative case study of two departments in one urban school in the USA. They proposed a more complex set of antecedents, including communication pathways, strategic knowledge leadership and resources dedicated to partnering. Indeed, leadership seems to be a relevant element in directing the whole process and in knowledge management in general (Pellegrini *et al.*, 2020). Both Da'as and Qadach (2018) and Zuckerman *et al.* (2018) explored leadership-AC relationships in both Israeli elementary schools and four rural odds-beating schools.

Despite these recent contributions, the identification of a clear set of antecedents in schools remains fragmented and several calls have been made for further development (Farrell *et al.*, 2019).

3. Research objectives

Two major challenges emerge from the existing literature. Firstly, no clarity in the case of school AC antecedents is observed. Secondly, no reliable measurement scale, let alone an empirical test, is available for use with regard to school AC. Our research design builds on the work of Da'as and Qadach (2018) and Zuckerman *et al.* (2018). We extend their results by applying a sequential explanatory mixed-method design using qualitative interviews followed by a quantitative survey (Hendren *et al.*, 2018). In Study 1, semi-structured interviews were conducted with 30 school principals to explore various antecedents to AC in schools. In Study 2, other semi-structured interviews were carried out with 30 teachers plus 30 school principals to develop a valid measurement scale for AC. These were then followed up with a pre-test. In Study 3, we tested our hypotheses on the perceptual data.

3.1 Study 1: developing a model for absorptive capacity antecedents

To rigorously develop a model for AC antecedents in the educational context, we conducted a qualitative in-depth study with elite informants. Aguinis and Solarino (2019, p. 1293) suggested that "elite informants are key decision makers who have extensive and exclusive information and the ability to influence important firm outcomes, either alone or jointly with others (e.g. on a board of directors)." Qualitative interviewing helps obtain rich data for building theories or explaining a phenomenon, with the help of experiences collected during the interviews. The semi-structured interview was chosen because it proves to be both flexible, accessible and intelligible (Qu and Dumay, 2011). The data was collected through face-to-face semi-structured interviews including a potential list of AC antecedents (Daghfous, 2004). We used a standardized protocol, asking each elite informant to indicate the antecedents to AC appropriate in the school context.

The participants were contacted through meetings of school principals. The criteria for the selection of the participants included experience and the type of schools found in Poland. Thus, the participants represented elementary school, post-elementary school, vocational school, secondary school and post-secondary school institutions. In addition, they also possessed extensive experience in the education sector. The majority of the participants were female (17), with a higher education degree, aged between 30 and 50. The interview duration was between 20 and 40 min (Table 1). Duration of particular interviews depended on respondents and in particular on their availability and spontaneousness while answering given open questions.

Based on information collected from the elite informants, we revised the list of antecedents to AC by Daghfous (2004). Principals suggested that the following antecedents were not appropriate in the context of their schools: gatekeepers, organizational structures, levels of cross-functional communication, organizational culture, company size, organizational inertia, human resource management, a combination of the external knowledge environment and the organization's position within the relevant knowledge network. They

Table 1 Interviewees' details (Study 1)

Code	*Interviewee position*	*School type*	*Interview duration*
H1	Headmistress	Elementary school	35 min
H2	Headmaster	Elementary school	30 min
H3	Headmaster	Secondary school	20 min
H4	Headmistress	Elementary school	30 min
H5	Headmaster	Elementary school	40 min
H6	Headmistress	Elementary school	35 min
H7	Headmaster	Elementary school	25 min
H8	Headmistress	Elementary school	20 min
H9	Headmistress	Post-elementary school	30 min
H10	Headmistress	Post-elementary school	35 min
H11	Headmaster	Post-elementary school	20 min
H12	Headmistress	Post-elementary school	25 min
H13	Headmaster	Post-elementary school	35 min
H14	Headmistress	Elementary school	40 min
H15	Headmaster	Secondary school	40 min
H16	Headmistress	Post-secondary school	20 min
H17	Headmaster	Post-secondary school	25 min
H18	Headmistress	Post-secondary school	30 min
H19	Headmaster	Elementary school	30 min
H20	Headmistress	Elementary school	30 min
H21	Headmistress	Post-secondary school	25 min
H22	Headmistress	Elementary school	40 min
H23	Headmaster	Elementary school	40 min
H24	Headmistress	Elementary school	20 min
H25	Headmaster	Elementary school	20 min
H26	Headmistress	Elementary school	20 min
H27	Headmaster	Post-secondary school	20 min
H28	Headmistress	Vocational school	20 min
H29	Headmistress	Elementary school	20 min
H30	Headmaster	Vocational school	20 min

also recognized the difficulty of assessing the precise amount of investment in R&D. Based on their indications, we established a set of four empirically grounded antecedents: prior knowledge, employees' skills, educational projects and interactions with the environment.

Prior knowledge consists of all individual knowledge units in the organization. Cohen and Levinthal (1990) suggest that AC is path-dependent and results from the cumulative nature of knowledge. Kim (1998) suggested that prior knowledge has a positive effect on AC because it helps to acknowledge the value of new information, as well as assimilate and apply the information in question. This is reflected in the words of one of the principals involved: *Thanks to new knowledge, our school is constantly developing and is able to develop something new* (H25). According to Zahra and George (2002, p. 191), "the breadth and depth of knowledge exposure positively influences a firm's propensity to explore new and related knowledge." This is substantiated by one of the principals: *We care about our knowledge all the time because we know it distinguishes us from other schools and allows us to acquire new knowledge* (H20). In an educational setting too, prior knowledge is an important antecedent to AC (Farrell and Coburn, 2017). In this case, prior knowledge creates a comprehensive learning organization and induces or intensifies schools' efforts to seek external knowledge. It also allows new, external knowledge resources to be identified and it improves schools' AC and understanding of proper mathematics content, pedagogical strategies and adult learning (Farrell *et al.*, 2019). One of respondents explains it in the following way: *New knowledge not only allows us to make better use of what we already have but also makes teachers want to improve and learn* (H2). Hence, the broader the prior knowledge of a school, the higher its AC can be expected, which can be summarized in the following manner:

P1. Prior knowledge positively influences the development of AC in schools.

Despite the fact that AC is an organizational construct, it is amplified by employees' interactions at the individual level and is then manifested as a collective phenomenon (Kozlowski and Klein, 2000). Thus, AC can also be considered at an individual level (Lane *et al.*, 2006) as it consists of the individual ability of employees to identify external knowledge and to assimilate and use it to generate performance benefits (Tian and Soo, 2018). This individual capacity is often measured as the skill set possessed by the employees, which results from both experience and professional learning and is reflected in the acquisition of professional qualifications. Employees' skills affect all dimensions of AC. Organizations are usually able to better absorb new knowledge if employees are highly skilled (Rothwell and Dodgson, 1991). Employees' skills give rise to creativity through new associations between new and old knowledge (Magni *et al.*, 2021). In this context, the ability to assimilate external knowledge fosters change and innovation within the organization (Schweisfurth and Raasch, 2018). This is evidenced by one of the principals involved: *Employees' skills definitely determine what school we are and how we use the resources we already have* (H25). In the school context, employees are encouraged to become knowledge workers. Such employees have the ability to analyse and use data to improve and transform existing practices. Employees' skills are claimed to be positively related to learning, searching for new information, processing and evaluating information with others, incorporating and using new ideas, generating ideas within the organization as well as importing them from outside, educational change and sustainable progress and building the capacity for fundamental change (Zinkeviciene, 2004). One of the principals emphasized that: *At school, teachers play an important* role *in enhancing professionalism in learning and acquiring knowledge* (H16). Schools have also been increasingly advocated to foster a learning culture and to build the capacity to initiate, support and sustain teacher learning (Kools *et al.*, 2020). This is substantiated by one of the respondents: *The importance of teachers in acquiring knowledge but also the need for the whole school to learn, is discussed at various trainings and conferences. As a school, we must enable the teacher to acquire a vocational education, thanks to which we gain new knowledge* (H3). Consequently, we predict that:

P2. Employees' skills positively influence the development of AC in schools.

An educational project is a collaborative process involving teachers and educational staff and is based on collaboration and organizational cooperation, as well as educational extension to innovative pedagogies. Zinkeviciene (2004) suggests that educational projects are important antecedents to AC because they help stimulate teachers' initiative and creativity, empower them, help recognize new knowledge, identify their advantages and use them in their own or their school activities. According to one of the respondents, an educational project enabled the school under their management to develop teachers' creativity and the ability to jointly seek new, inspiring sources of new knowledge: *It is a valuable experience for us. Teachers have learned to acquire knowledge on their own and have acquired the ability to cooperate* (H15). Project participants share information, broaden the scope of their prior knowledge and use it in school processes and structures, which further increases school AC. According to Fernández and Brito (2019, p. 12) "teachers recognize in the project an opportunity to propose strategies to improve the learning conditions and coexistence in schools." This is reflected in the words of one of the principals: *Educational projects allow teachers to develop the knowledge they possess and to search for solutions related to the functioning of the school* (H20). Notably, educational projects contribute to the development of the knowledge the school possesses, they encourage the search for new knowledge and they mobilize school personnel to adopt the knowledge in question (Deschesnes *et al.*, 2013). As one of the principals said: *Our educational project made teachers want to want. They have become more ambitious and*

know that new knowledge is needed for their school's development (H19). Thus, we expect that:

P3. Educational projects positively influence the development of AC in schools.

Finally, external knowledge is knowledge located outside an organization's boundaries and can be acquired through other organizations by attracting qualified researchers embodying relevant knowledge, licensing and/or exchanging knowledge through contracting out R&D (Caloghirou *et al.*, 2002). External knowledge provides the organization with more options for approaching problems from different perspectives and facilitates innovations by offering new insights that complement internal efforts (Cruz-González *et al.*, 2015; Nicotra *et al.*, 2014; Scuotto *et al.*, 2017a, 2017b), as well as providing greater prospects for the combination and recombination of knowledge (Fleming and Sorenson, 2004). Of course, this external knowledge can be more easily reached when an organization is embedded in a knowledge network. Such networks are open and self-organized systems in which knowledge evolves and diffuses through innovation and communication (Cowan and Jonard, 2004). For example, according to Tsai (2001), a knowledge network provides access to new knowledge developed by other organizations. On the other hand, if organizations occupy central network positions, they can produce more innovations and enjoy better performance and the position in the knowledge network improves abilities to absorb innovative practices because of sharing information (Giusti *et al.*, 2020). This is reflected by one of the principals: My school belongs to an educational cluster. We meet regularly with school principals from all over the province. These meetings allow us to obtain information that is relevant to us. We also use good practices and we are changing (H14). Condensing these insights, Farrell and Coburn (2017) argue that school interactions with the environment are antecedents to AC that are likely to promote organizational learning and change. Schools can draw on their expertise and capacity and innovative ideas and practices implemented in individual schools can be developed by networked learning organizations. This is substantiated as follows: Thanks to cooperation with others, we know how to do something better, we know where the sources of the new are, where to look for valuable knowledge and how to use it (H14). In the school context, interactions with various partners and communities can contribute to improving the quality of teaching and gaining access to knowledge in the school environment (Farrell *et al.*, 2019). This is reflected in the words one of the principals: Cooperation allows us to see how others do something. This allows us to learn and constantly look for new products that are valuable to us (H27). Hence, we formulate that:

P4. Interactions with the environment positively influence the development of AC in schools.

Thanks to these results we were able to provide a response to our first research question (*RQ1*).

3.2 Study 2: developing a measurement scale

Following Da'as and Qadach (2018), we recognize that despite growing interest in AC in schools, no measurement scale adapted to such a context has been validated yet. Therefore, we developed and rigorously validated our measurement scale for AC, generating an initial inventory of items based on AC literature and then conducting a pilot study to refine the scale according to respondents' feedback.

To develop an overall AC scale, we started by investigating its antecedents. In particular, for the most influential elements that emerged from Study 1, we adopted a multi-step protocol in which we triangulated teachers' and principals' perspectives and then we validate these results with another sample of principals. In order, we started contacting 30 teachers working in each type of school found in Poland (i.e. elementary school, post-elementary school, vocational school, secondary school and post-secondary school).

Interviewees were asked to point out any items that were either ambiguous or difficult to answer. Although prior literature does not offer validated measurements for AC antecedents specific to the school context, a scale for single antecedents already existed and so we started from these item inventories.

Then, we ran a face validity assessment during the annual meeting of Polish principals and collected comments from 30 participants, still stratified according to the type of school found in Poland. Respondents were asked to read each item and evaluate it in the context of its clarity and accuracy in the school context. Additionally, respondents were asked questions referring to acquisition, assimilation, transformation and exploitation of new knowledge in the school context. In this, the active role of principals was substantial and according to their comments, we were careful to refine our original scale. Thus, the items were checked for clarity and phrasing, as well as relevance to their respective content domains.

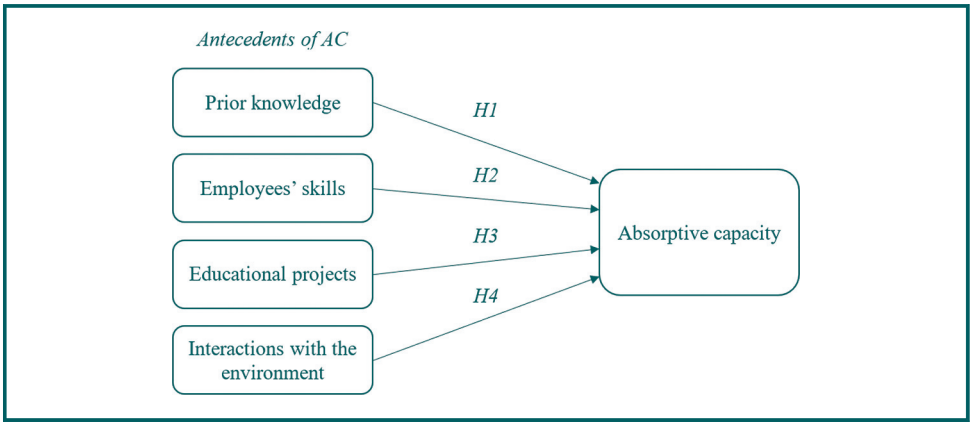
To measure prior knowledge, we adopted the approach of Bierly and Chakrabarti (2009). After triangulating the comments of school teachers and principals, the adopted scale consisted of 10 questions. Employees' skills were assessed using scales adapted from Rothwell and Dodgson (1991) and at the end of the triangulation process, it consisted of 17 formulations. To measure interactions with the environment, we adopted the Appleyard (1996) approach and the final scale consisted of 21 questions. To measure educational projects, the results coming from the teachers' interviews were inconsistent, thus we mainly relied on the school principals' indications. We developed a sub-set of 18 items for assessing educational projects. Similarly, we also developed an AC scale for its dimensions/processes in the school. To do so, we reviewed relevant literature based on the dimensions that had been defined by Flatten *et al.* (2011) and included a set of pre-defined item inventories (Cohen and Levinthal, 1990; Van Den Bosch *et al.*, 2003; Zahra and George, 2002). As premised, we preferred using only the self-reported retrospective perceptions of school principals in relation to AC processes. Those processes are not designed by the teaching staff, and thus, their perceptions may lack of consistency.

The overall process allows for developing a draft version of the AC survey instrument. All items on the measurement scale were translated from Polish by the authors and were measured using a five-point Likert scale with response options ranging from 1 – "strongly disagree" to 5 – "strongly agree." All the items included in the scales are reproduced in the Appendix. To test for primary scale characteristics, a pilot survey was conducted involving 30 other school principals. Again, the selection of respondents for our pilot survey was purposeful, conscious and intentional, especially in terms of diversity, education background and type of school (Eisenhardt and Graebner, 2007; Siggelkow, 2007). However, the respondents were all elite informants with extensive amounts of experience in education. Experts presented detailed feedback that led to the modification of some items. This eventually resulted in obtaining a final version of the AC questionnaire, which included 141 items measured on the five-point Likert scale (1 – "strongly disagree" to 5 – "strongly agree"), specifically 66 measuring the antecedents to AC and 75 for AC dimensions/processes. Thanks to these results we were able to provide a response to our second research question (*RQ2*).

3.3 Study 3: testing a model for school absorptive capacity

We transformed our set of propositions developed in Study 1 into proper hypotheses. Our research model postulates that: *H1: Prior knowledge is positively related to School AC; H2: Employees' skills are positively related to School AC; H3: Educational projects are positively related to School AC*; *H4: Interactions with the environment are positively related to School AC*. This is visually summarized in Figure 1.

Figure 1 Research design (Study 3)



We conducted our research in schools in Poland. The sample comes from the Educational Information System from the ministerial register of schools in Poland. It includes 3,594 schools. Firstly, we calculated the minimum sample size. To take it into account, we assumed the value of acceptable measurement error (5%). We established a minimum sample size of 385 schools.

We sent our online questionnaire to selected school principals in three waves. In addition, to reduce the non-response error, we conducted data collection in a mixed mode, i.e. using online surveys, forms available on the online platform Webankieta.pl and questionnaires sent by email. The type of data collection techniques depended on the choices made by respondents after being invited to participate in our research. Although collecting data using different methods may cause some differences in respondents' answers, the use of a multi-source approach and multiple methods for collecting data is relevant to the response rate, which is particularly important for studies focused on small target populations.

In total, we collected 151 correctly and thoroughly completed questionnaires (response rate: 39.22%). Our high response rate may be linked to the endorsement of our research project by the National Association of Education Management Staff – the largest and most prestigious Polish organization associating school principals. The schools participating in the study were primarily public schools (96.69%), including secondary schools (23.84%) and primary schools (21.85%) located in cities with a population of 101,000–200,000 inhabitants (25.16%). The study respondents included school principals (100%), who were predominantly female (78.14%) and over 50 years old (39.07%) with higher education (100%).

3.4 Data analysis

We used correlation, reliability, convergent validity and discriminant validity procedures, typical for mixed-method studies (Lenart-Gansiniec, 2021).

Firstly, the correlation analysis measured the association between the antecedents and the dimensions of AC. We have obtained statistically significant deviations from the normal distribution, which allowed us to move on to advanced analysis of the partial least squares structural equation modelling (PLS-SEM) model.

Secondly, we used the composite reliability values to examine reliability including: confirmatory factor analysis (CFA), Cronbach's alpha, Harman's one-factor test and Kruskal-Wallis test. The CFA was used for construct validation and identification of the final factor structure (McNeish and Wolf, 2020). Cronbach's alpha was used to assess the

reliability of the questionnaire because it is "one of the most important and pervasive statistics in research involving test construction and use" (Cortina, 1993, p. 98). We used Harman's one-factor test to identify the measurement context effect. This resulted from the fact that the applied measurement of all variables done at the same time by means of the questionnaire survey may lead to common methods bias (Podsakoff *et al.*, 2003). Next, to find statistical differences in the relative importance of individual dimensions and AC antecedents, due to failure to meet the assumption of normality of distribution ($p = 0.0001$), we performed the Kruskal-Wallis test. We adopted a multi-part approach (Rovai *et al.*, 2014) and performed all calculations for mean values.

Finally, we used PLS-SEM to test our hypotheses and validate the measurements. This method allows for estimating measures of theoretical constructs, their reliability and validity. It also enables us to test directional relationships between complex constructs (Chin, 2010).

Data analysis was performed by means of the following software: SmartPLS 3 and PS IMAGO Pro 5. IBM SPSS Statistics version 17 and STATISTICA 10.0 were used for calculations. Thanks to these results we were able to provide a response to our last research question (*RQ3*).

4. Results

4.1 Correlation, reliability and validity analysis

In relation to correlation analysis, we carried out statistical analyses for all of the variables using non-parametric statistical methods. We used correlation analysis with Spearman's coefficients. The calculations were based on averages, as we adopted a multi-part approach for the variables (Rovai *et al.*, 2014). As the results show, AC antecedents are positively correlated to AC, in its overall conceptualization and in its dimensions/processes (Table 2). However, the latter relationships are rather moderate.

The CFA was used with established thresholds for key indexes: with respect to $X2$, a good fit occurs when the value is <5; the root mean square error of approximation (RMSEA) coefficients for perfectly matched models are 0.01; for goodness-of-fit index (GFI), if the index value is >0.95, it indicates a better degree of model fit; for adjusted goodness-of-fit index (AGFI), if its value is >0.90, it indicates a good degree of model fit. We obtained the following results: $X2 = 10.674$, $p < 0.001$; RMSEA = 0.017, GFI = 0.964, AGFI = 0.820, which allows us to confirm good fit our model and can be considered acceptable.

As seen in Table 3, in AC there were four distinct clusters of items with moderate to high reliability coefficients (Cronbach's alpha):

Table 2 Correlation matrix

	Absorptive capacity antecedents			
Variables	*Prior knowledge*	*Employees' skills*	*Educational projects*	*Interactions with the environment*
Absorptive capacity (overall)	0.459**	0.539**	0.364**	0.568**
Absorptive capacity dimensions				
Acquisition	0.368**	0.501**	0.387**	0.631**
Assimilation	0.321**	0.402**	0.188*	0.357**
Transformation	0.359**	0.382**	0.166*	0.375**
Exploitation	0.491**	0.519**	0.493**	0.552**

Notes: **Correlation is significant at the 0.01 level (two-tail); *Correlation is significant at the 0.05 level (two-tail)

Table 3 Descriptive statistics of involved variables

Variables	*Mean*	*SD*	*Min*	*Max*	*Cronbach's alpha (α)*
Absorptive capacity (overall)	5,277	0.574	2,245	6,650	0.858
Absorptive capacity dimensions					
Acquisition	5,308	0.565	2,826	6,608	0.761
Assimilation	5,346	0.657	1,368	6,789	0.616
Transformation	5,271	0.811	1,375	7,000	0.814
Exploitation	5,183	0.712	2,941	7,000	0.886
Absorptive capacity antecedents					
Prior knowledge	4,794	0.696	3,000	6,700	0.649
Employees' skills	5,602	0.580	2,176	6,882	0.760
Educational projects	5,057	0.891	1,333	6,555	0.875
Interactions with the environment	5,406	0.595	3,857	6,904	0.787

- acquisition (23 items, 0.761);
- assimilation (19 items, 0.616); and
- transformation (16 items, 0.814) and exploitation (17 items, 0.886).

There were also four antecedents to AC in distinct clusters of items with moderate to high reliability coefficients (Cronbach's alpha), namely, prior knowledge (10 items, 0.649); employees' skills (17 items, 0.760); interactions with the environment (21 items, 0.787) and educational projects (18 items, 0.875). Cronbach's alpha for the overall AC reliability of the full scale of 75 questions was α = 0.858, which indicates high internal coherence. The Cronbach's alpha value for the AC antecedents as measured by 66 elements is very satisfactory (0.901). The reliability coefficient for the questionnaire as a whole (141 items) was 0.926, indicating high internal consistency. Values, thus, ranged from 0.71 to 0.875, higher than the standard 0.7 cut-off (Nunnally, 1978), which supports the reliability of the measurement scale.

We also used Harman's single factor test to check for common method variance. We obtained the following results: 56.145% (variance of the one-factor solution) and 61.018% (variance of the univariate solution). We conclude that our tool is not exposed to measurement bias and common method bias does not exist.

To determine average values for the variables, we examined responses using descriptive statistics. The average values indicate that employees' skills are the most important antecedent that affect AC in schools. We noted small differences between the averages for the four antecedents. Only in the case of prior knowledge did our respondents exhibit moderate evaluations. Regarding the dimensions of AC, we conducted a nonparametric Kruskal-Wallis test aimed at verification of AC processes. The results (H = 4.9287; df = 3; p = 0.1771 > 0.05) suggest that all AC processes have the same importance. There are no statistically significant differences in the assessment of AC processes. We find that there are statistically significant differences in the assessment of AC antecedents (H = 120.2; df = 3; p = 0.0000 < 0.05). To obtain complete information about how the n-means differ from each other and which of them are equal, we used the post-hoc test. We found that the skills of employees are the highest rated antecedent, while the lowest refers to assessed prior knowledge. Interactions with the environment are more important than the prior knowledge and educational projects, but they are less important than employees' skills. Educational projects are better rated than prior knowledge, although they are less important than employees' skills and interaction with the environment.

4.2 Structural model

Prior to SEM, it is important to examine the relationships between the latent variables and their items. The study measurement model was further assessed based on composite reliability, outer loadings, Cronbach's alpha, average variance extracted (AVE) and discriminant validity (Wong, 2013). In our study, the square roots of each construct AVEs are above the minimum of 0.60 – all of the constructs have unsatisfactory convergent validity. We can accept an AVE of <0.5 if the composite reliability is >0.6 because the convergent validity of the construct is still adequate (Fornell and Larcker, 1981). Composite and internal validity (Cronbach's α) suggest that our measures are robust in terms of their internal consistency reliability. Once a satisfactory assessment of the measurement model was achieved, it was possible to further evaluate the structural model.

Table 4 shows the path coefficients for the four models tested. The bootstrapping procedure (for 500 bootstrap samples) allowed us to evaluate the statistical significance of all relations included in the research model. We first checked that the model sufficiently explained the empirical data. For this purpose, we used a global Goodness-of-Fit index (Tenenhaus *et al.*, 2005). We obtained a result of 0.44, which confirms the data fitted the model at a high level (Wetzels *et al.*, 2009). Our model explains 68.3% of the variance in AC, which indicates a moderate level of explanatory power (Moore *et al.*, 2013). Additionally, the standardized root mean square residual is 0.096, which is satisfactory goodness of fit.

In *H1*, we predicted that prior knowledge would positively influence AC in schools. As predicted, the findings in Table 3 confirmed that prior knowledge affects AC (b = 0.191, T = 2.987, $p < 0.005$). Hence, *H1* was supported. Furthermore, when observing the positive impact of employees' skills on AC in schools (*H2*), the findings from Table 4 endorsed that the employees' skills positively affect AC (b = 0.380, T = 3.206, $p < 0.005$) and confirmed *H2*. Educational projects have a similarly positive but weak influence (b = 0.144, T = 1.911, $p > 0.05$) on AC. Educational projects affect AC in a marginally but significant way, therefore, supporting *H3*. Finally, interactions with the environment positively affect the AC in schools (b = 0.318, T = 2.942, $p < 0.005$), showing that *H4* was supported.

5. Discussion

In this study, we identify context-specific antecedents to schools' AC and to test their relationships through a validated measurement scale. We find support for all four hypothesized relationships. In more detail, prior knowledge (*H1*), employees' skills (*H2*), educational projects (*H3*) and interactions with the environment (*H4*), all positively and significantly influence AC in schools. It is important to note that interactions with the environment were found to be the most significant antecedent of schools' AC – a finding that supports recent findings by Farrell and Coburn (2017) and Farrell *et al.* (2019).

Overall, our study shows that AC is a complex nexus of interactions, and therefore, to better untangle it, we created an interpretative framework to show how a "virtuous learning circle" may work.

Table 4 Results of PLS-SEM analysis

Hypothesis	*Path coefficient*	T-*statistic (sig. level)*	p-*values*
H1. Prior knowledge -> absorptive capacity	0.191	2.987	0.003
H2. Employees' skills -> absorptive capacity	0.380	3.206	0.001
H3. Educational projects -> absorptive capacity	0.144	1.911	0.057
H3. Interactions with the environment -> absorptive capacity	0.318	2.942	0.003

The basic assumption of the model is that "absorptive capacity is not developed as a sequential process of building knowledge, rather [...] a process built over cycles of learning that overlap" (Marabelli and Newell, 2009, p. 5). Therefore, we also interpret AC antecedents as stratified levels that interact each other, with a similar logic to that of Volberda *et al.* (2010). In particular, we see three layers, namely, the individual level (micro), the organizational level (meso) and finally an upper layer related to the environmental and institutional level (macro).

At the individual level, employees' prior knowledge is a powerful tool through which employees can improve the assessment and better frame the current situation. Doing so means benefitting and exploiting the most from contingences (Farrell and Coburn, 2017). Yet, employees' skills are also positively related to AC (Kools *et al.*, 2020). Without proper competencies, employees are not able to execute and govern concrete performance (Zinkeviciene, 2004), regardless of their ability to frame the situation. This supports the view that organizational knowledge and related concepts such as AC are strongly rooted in individual level constructs.

However, individual endeavours also need some organizational support. Our study showed that educational projects positively influence the development of AC in schools (Deschesnes *et al.*, 2013). Specifically, working on projects contributes to the creation of tacit knowledge and knowledge sharing that leads to the creation of an environment and culture conducive to learning and the development of knowledge practices. This culture, in turn, is able to fully valorize and capitalize on the human capital, and thus, the individual level strengths (Fernández and Brito, 2019).

Finally, the last level is direct interaction with the environment. AC naturally relies on the proximate environment and the inter-organizational relationships a focal entity is able to establish. Indeed, the more interactions, the greater the likelihood of establishing relationships with external partners. These ties are important for accessing knowledge and other resources, and thus, supporting changes and improvements in school systems (Farrell *et al.*, 2019). However, without a solid organizational climate in which to properly use these new resources, the benefits may be limited. Thus, all three levels/layers are intertwined and need to be orchestrated jointly; lower-layer benefits are promoted by upper levels, which, in turn, need the lower level "building blocks" to allow AC to operate properly. The challenge is to harness knowledge at every level through the processes of AC, and thus, generating a "virtuous learning circle." Through its four processes:

1. acquisition;
2. assimilation;
3. transformation; and
4. exploitation, AC has to be seen as recursive.

This circle is a loop of processes whereby subsequent performances capitalize on prior results, if these are positive and this allows the loop to be repeated with ever increasing results. To summarize, Figure 2 visually represents our interpretative model.

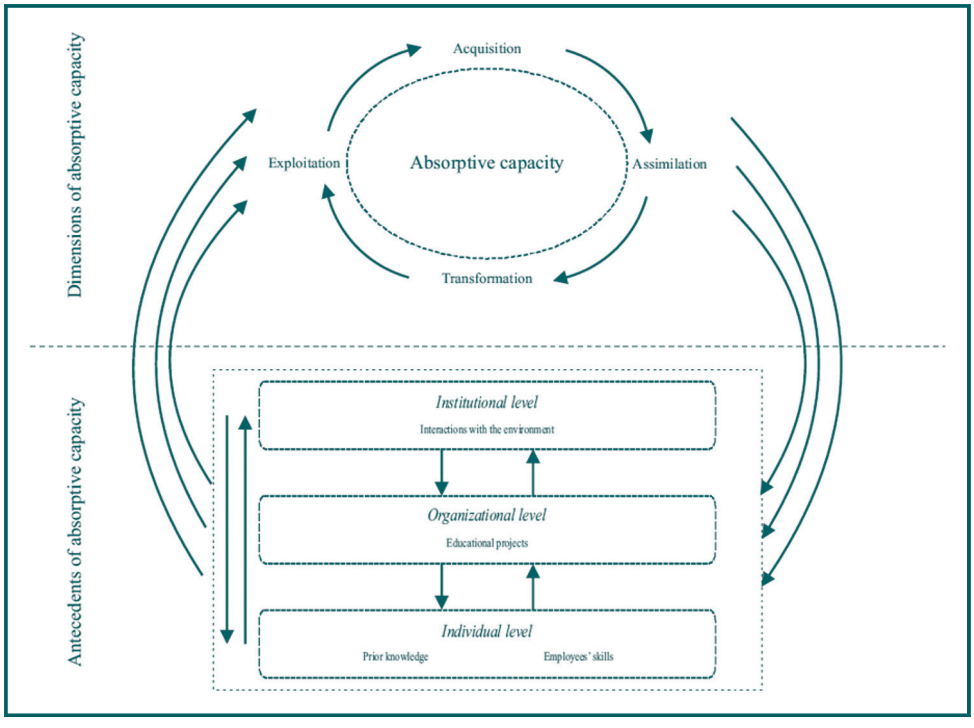
6. Implications and concluding remarks

6.1 Theory contributions

Thanks to our mixed-methods approach, we have shed more light on the relationships between AC, organizational learning and knowledge management literature.

Our study advances research into AC in schools, which so far has mainly focused on efficiency, effectiveness, responsiveness, organizational learning and competitive advantage (Harris and Jones, 2018; Schleicher, 2015; Stoll and Kools, 2017).

Figure 2 Interpretetive model: the AC virtuous circle



Recently meanwhile, researchers have called for a shift of focus towards the antecedents to AC (Da'as and Qadach, 2018; Farrell *et al.*, 2019; Rezaei-Zadeh and Darwish, 2016; Zuckerman *et al.*, 2018). This is necessary to better understand where AC stems from and subsequently how it can be shaped/developed. Although some research has analysed the antecedents to AC in schools (Da'as and Qadach, 2018; Deschesnes *et al.*, 2013; Farrell and Coburn, 2017; Farrell *et al.*, 2019; Fernández and Brito, 2019; Zuckerman *et al.*, 2018), there is still no in-depth research or comprehensive results (Farrell *et al.*, 2019). We have complemented earlier works, especially in terms of inclusiveness, as the results of Study 1 were based on respondents from all types of school: elementary school, post-elementary school, vocational school, secondary school and post-secondary school. Secondly, our research allows for an in-depth understanding of the measurement scale for AC in schools (Da'as and Qadach, 2018). The combination of literature-driven and triangulations of expert inputs (Study 2) allowed us to develop a survey questionnaire consisting of 141 items that captures both AC antecedents and dimensions (Zahra and George, 2002). In addition, we carried out quantitative research to test the hypotheses developed in the qualitative design (Study 3). This complex approach stems from the fact that the AC concept is intangible, subtle and hard to grasp (Todorova and Durisin, 2007). Mixed methods are most likely the best for capturing the whole extent of AC (Pérez Sánchez and Toro-Jaramillo, 2018; Sedoglavich *et al.*, 2015). So far, the efforts undertaken have been limited to qualitative research. Thus, we extend and enhance existing findings through the use of a recommended quantitative approach (Lenart-Gansiniec, 2021). This mixed approach study provides solid ground for future endeavours in this research context.

Finally, our study contributes to organizational learning theory (Argyris and Schön, 1996) by providing a theoretical model of AC virtuous learning circles that explains the ways in which AC develops and improves (Marabelli and Newell, 2009; Vera *et al.*, 2015). In this way, we postulate the necessity for schools to learn (Kools *et al.*, 2020). We have developed an interpretative model called the "virtuous learning circle," where we assume that AC is a

subset of organizational learning. Our research has allowed us to establish that AC requires shaping integrated activities and investments that produce significant learning-intensive results. In this view, AC is an important factor of learning processes. As stated by Monari and Kuria (2015, p. 40) "to understand the absorptive capability of an organization, the theory of organizational learning is vital; organizations that are inclined towards learning should develop their ability to acquire and adopt external knowledge and transfer the acquired knowledge."

6.2 Implications for practice

Our study also has a very practical orientation, giving precise suggestions about how to develop AC in schools. We want to provide best practices to help principals change knowledge management routines and to improve AC. This can be achieved with a systematic and dexterous targeting of its antecedents.

- Developing AC requires schools to have some prior knowledge, as it has impacts on innovative processes, improvement of services, obtaining the expected current results and building an advantage over competitors (Tichnor-Wagner *et al.*, 2016; Silins and Mulford, 2004). School leadership should be well aware of the knowledge already possessed by the organization and especially its staff. This allows the internal and external environment to be properly screened and redundant duplications to be avoided. Thus, there is a need to periodically measure and evaluate the resources held by the organization and to strive to maximize the use of knowledge resources (Farrell and Coburn, 2017).
- The skills of employees contribute to increasing AC in the entire organization as they stimulate the exchange of acquired knowledge. An appropriate number of specialists enables the school to efficaciously access knowledge outside the organization (Rothwell and Dodgson, 1991). Additionally, an important element is a differentiation in the specialists' backgrounds as it ensures that knowledge can be acquired from several domains/networks and new associations, connections and innovations can be created (Schweisfurth and Raasch, 2018). This may also be done through a new recruiting process; new staff members' knowledge resources should be merged harmonically with that of more senior employees. To do so, knowledge sharing processes should be encouraged (Kozlowski and Klein, 2000; Rafique *et al.*, 2018), enabling transfer and integration of different types of knowledge. Reluctance or resistance to sharing knowledge can pose a serious threat to the development of AC. Therefore, the management of the school should undertake activities aimed at promoting and forming skills but also stressing the importance of sharing knowledge and of the openness to the knowledge of other employees (Kools *et al.*, 2020). Otherwise, the full potential of acquiring new knowledge will be not unleashed. It should be remembered that school employees may show resistance and reluctance to sharing knowledge but also to incorporating new knowledge into their work. In this perspective, employees should be encouraged to acquire knowledge not only through formal training but also through participation in communities of practice. In addition, it is recommended that incentive and loyalty systems be implemented that will prevent an outflow of knowledge from the school along with the departure of employees.
- The participation of schools in educational projects not only facilitates access to new sources of knowledge but also changes the image of the school (Zinkeviciene, 2004). Launching frequent educational projects offers a promising organizational opportunity for staff members to interact outside the traditional hierarchy or functional approach (Deschesnes *et al.*, 2013). On the one hand, the school will be perceived as a dynamic organization, open to change and responding to the requirements of the environment. This aspect is particularly relevant if local governments abolish the policy of "zoning,"

so that the family or students face no limitations when deciding on the future school. In this case, schools are forced to undertake competitive, marketing, promotional and image-building activities. School leadership should remember that students are also followed by financial resources in the form of educational subsidies. On the other hand, schools' participation in educational projects may cause parents and students to perceive such an environment as too demanding and challenging, opting instead for less "completive cultures." Therefore, it is suggested to clearly "signal" and convey information to the media about the benefits generated by educational projects.

- Principals should recognize that a school is not an isolated island and purposefully engage with stakeholders and the proximate environment. This process expands the traditional knowledge territories available for the school and in doing so opens up for new opportunities for development (Farrell and Coburn, 2017; Farrell *et al.*, 2019). Indeed, self-generation of knowledge poses risks, lengthens the knowledge base build-up time and also limits the development of AC. Thus, cooperation may smoothen and hasten the process, nevertheless, external sources of knowledge may be rejected by the staff. Of course, in many educational systems, cooperation with the environment becomes obligatory, but the school management should remember that only when acquired knowledge is combined with the knowledge possessed by the organization, can it become valuable and generate a synergy effect. Creating incentive systems for those involved in knowledge processes, as well as cooperation with the environment, may reduce this problem.
- We want to emphasize the interconnected nature of these recommendations. Focusing solely on initiatives involving a wide range of stakeholders in the functioning of the school may not be sufficient for developing AC, as it is an organizational process that depends on the context and on organizational practices. Schools should continuously readjust and refine their strategies and approaches in response to the feedback received. A knowledge system cannot be fixed or unidirectional, and therefore, not considering the individual, organizational and environmental issues encountered is detrimental. School leadership should design an organizational system that can face new challenges and adapt to constant changes. This is possible by creating an attractive and clear vision of the future of the school, increasing the optimism and enthusiasm of employees and their involvement, encouraging openness and searching for new opportunities for acquiring knowledge and learning.
- In addition, our study develops and validates a measurement scale that can be considered as a "ready-to use" tool at the disposition of school principals. Our questionnaire, precisely tailored for the educational setting, can easily be used to self-assess the AC situation in the school. Increasing awareness of current contingencies is the first step in developing a coherent plan of interventions for further development of AC and for activating all the practical recommendations provided in this section.

6.3 Limitations and future research directions

We are aware that our study is burdened with some limitations. In particular, it is contextually limited by focusing on Polish schools. It is, therefore, recommended that further research should replicate our measurement scale and model in other countries. Another limitation is connected to the self-reported data used in our study, which may be a threat of the declarative method of measuring variables and the measurement context effect. However, Harman's single factor test results indicate that in our study these errors did not occur. In addition, we conducted the study using a proprietary survey questionnaire that encourages further research and validation. Finally, in our study, we define AC as organizational routines and processes, therefore, it would be interesting to consider longitudinal research designs in future studies. This will allow to capture and collect data over a longer time horizon and to observe the importance of individual antecedents for AC.

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Appendix

Table A1 Measurement items

Item no.	*Statement*
Antecedent of absorptive capacity: prior knowledge	
PK1	At my school, the diagnosis of employees' knowledge is considered a high priority
PK2	At my school, employees have information about the qualifications of other employees
PK3	At my school, we do knowledge mapping
PK4	At my school, we carry out a topography of knowledge
PK5	At my school, we make minutes of the meetings
PK6	At my school, we place the information obtained during the training on the e-learning platform
PK7	At my school, we place information obtained during training sessions on the Intranet
PK8	At my school, we have a public library with training materials
PK9	At my school, employees have access to training materials
PK10	At my school, school headmaster/mistress knows the level of knowledge and skills of employees
Antecedent of absorptive capacity: employee skills	
ES1	At my school, professional learning of staff is considered a high priority
ES2	At my school, school headmaster/mistress facilitates individual and group learning
ES3	At my school, employees take the initiative to improve their professional qualifications
ES3	At my school, school headmaster/mistress expects the employees to take care of raising their professional qualifications on their own
ES4	At my school, school headmaster/mistress provides employees with the opportunity to improve their professional qualifications
ES5	At my school, school headmaster/mistress motivates employees to improve their professional qualifications
ES6	At my school, the school finances the entire participation of employees in improving professional qualifications
ES7	At my school, the school partially finances the participation of employees in improving professional qualifications
ES8	At my school, employees are given days off while improving their professional qualifications
ES9	At my school, employees regularly participate in internal training and courses
ES10	At my school, employees regularly participate in training and courses organized by external training institutions
ES11	At my school, the professional qualifications of employees are assessed on the basis of observation of lessons
ES12	At my school, the professional qualifications of employees are assessed through internal evaluation
ES13	At my school, all new staff receives sufficient support to help them in their new role
ES14	At my school, employees periodically complete self-assessment sheets for their work
ES15	At my school, school records kept by teachers are subject to regular checks
ES16	At my school, employees regularly receive feedback on their professional qualifications
ES17	At my school, employees are encouraged to improve their professional qualifications
Antecedent of absorptive capacity: interactions with the environment	
IE1	At my school, we organize social gatherings/integration events for the residents of the district where the school is located
IE2	At my school, we work with parents of our students to take joint action for the benefit of the school
IE3	At my school, we work with school networks to deepen the knowledge and skills of staff and students
IE4	At my school, we cooperate with universities to deepen the knowledge and skills of employees and students
IE5	At my school, we have signed cooperation agreements with universities
IE6	At my school, we organize trips to local employers
IE7	At my school, we cooperate with the principals of other schools as part of the organization of various projects
IE8	At my school, we organize various events with local entrepreneurs
IE9	At my school, we work with NGOs to deepen the knowledge and skills of employees and students
IE10	At my school, we recruit sponsors for our initiatives
IE11	At my school, employees collaborate with teachers from other schools
IE12	At my school, we exchange information with other schools
IE13	At my school, we exchange information with other schools through direct contacts
IE14	At my school, we exchange information with other schools through telephone contacts
IE15	At my school, we exchange information with other schools via fax
IE16	At my school, we exchange information with other schools via e-mail
IE17	At my school, we have established procedures for establishing cooperation with the environment
IE18	At my school, we work with local media
IE19	At my school, we cooperate with students from other schools
IE20	At my school, we monitor our school's graduates
IE21	At my school, we monitor the effectiveness of cooperation with the environment

(*continued*)

Table A1

Item no.	*Statement*
Antecedent of absorptive capacity: educational projects	
EP1	At my school, over the past year, we have been involved in an educational project
EP2	At my school, we initiated an educational project over the past year
EP3	At my school, educational projects are considered a high priority
EP4	At my school, external partners are invited to educational projects
EP5	At my school, the school headmasters/mistresses initiates educational projects
EP6	At my school, employees initiate educational projects
EP7	At my school, we obtain information about educational projects from the website of the Ministry of National Education
EP8	At my school, we obtain information about educational projects from the educational press
EP9	At my school, we receive information about educational projects from employees of the Board of Education
EP10	At my school, we obtain information about educational projects from leaflets and posters
EP11	At my school, the school development plan is based on improvement through participation in educational projects
EP12	At my school, the new core curriculum requires participation
EP13	At my school, educational projects are an opportunity for us to improve pupils' competences
EP14	At my school, educational projects are an opportunity for us to improve professional competences of employees
EP15	At my school, educational projects are an opportunity for us to improve functioning of the school
EP16	At my school, educational projects are an opportunity for us to innovate at school
EP17	At my school, educational projects are an opportunity for us to change the way we think and act
EP18	At my school, educational projects are an opportunity for us to learn
Absorptive capacity: acquisition	
ACQ1	At my school, we place emphasis on searching for new knowledge
ACQ2	At my school, we acquire new knowledge through formal information exchange with other schools
ACQ3	At my school, we gain new knowledge by participating in educational conferences
ACQ4	At my school, we acquire new knowledge in the course of involvement in joint projects with other schools
ACQ5	At my school, we gain new knowledge from reading educational magazines
ACQ6	At my school, we acquire new knowledge by participation of employees in workshops and meetings with a methodological advisor
ACQ7	At my school, we acquire new knowledge by attending e-learning courses
ACQ8	At my school, we acquire new knowledge by participation of employees in external training/post-graduate studies/ courses
ACQ9	At my school, we acquire new knowledge by reading social media and internet resources
ACQ10	At my school, we gain new knowledge from the analysis of pupil's satisfaction surveys
ACQ11	At my school, our experience so far is a source of new knowledge
ACQ12	At my school, contacts with graduates are a source of new knowledge
ACQ13	At my school, the school headmasters/mistresses initiates activities that enable the acquisition of new knowledge
ACQ14	At my school, employees initiate activities that enable the acquisition of new knowledge
ACQ15	At my school, employees who initiate activities enabling the acquisition of new knowledge are appreciated
ACQ16	At my school, we want to improve and this way we gain new knowledge
ACQ17	At my school, the fear of closing the facility is dictated by the desire to acquire new knowledge
ACQ18	At my school, the statutory obligation requires us to acquire new knowledge
ACQ19	At my school, employees help each other acquire new knowledge
ACQ20	At my school, the school headmasters/mistresses trusts employees with responsibility for acquiring new knowledge
ACQ21	At my school, employees listen to the ideas and opinions of other employees
ACQ22	At my school, employees are open to new knowledge
ACQ23	At my school, we have implemented an incentive system that encourages the acquisition of new knowledge
Absorptive capacity: assimilation	
ASS1	At my school, ideas and concepts are communicated cross-employee
ASS2	At my school, when imparting knowledge, employees use jargon known only to education professionals
ASS3	At my school, if an employee obtains important information, it communicates this information promptly to all other employees
ASS4	At my school, the distribution of knowledge between employees is rewarded
ASS5	At my school, employees receive support in distributing knowledge to other employees
ASS6	At my school, there is a quick information flow
ASS7	At my school, the school headmasters/mistresses places emphasis on distributing knowledge to other employees
ASS8	At my school, employees are eager to exchange knowledge with other employees
ASS 9	At my school, knowledge is imparted through informal contacts
ASS10	At my school, knowledge is imparted through formal meetings

(*continued*)

Table A1

Item no.	*Statement*
ASS11	At my school, the knowledge of school leavers is passed on to their successors
ASS12	At my school, knowledge is distributed through IT systems
ASS13	At my school, employees willingly share of knowledge with their colleagues
ASS14	At my school, employees are open to distribute of knowledge
ASS15	At my school, there are procedures to facilitate the distribute of knowledge
ASS16	At my school, it is time to impart knowledge
ASS17	At my school, there is a dedicated place for teaching knowledge
ASS18	At my school, communication methods have been developed to enable distribution of knowledge
ASS19	At my school, employees help each other to distribute knowledge
Absorptive capacity: transformation	
TRS1	At my school, employees are used to absorbing new knowledge and transferring
TRS2	At my school, employees transform information from internal and external sources into valuable knowledge for our school
TRS3	At my school, the school headmaster/mistress links existing knowledge with new insights
TRS4	At my school, employees link existing knowledge with new insights
TRS5	At my school, procedures emphasize reuse of insights out of past activities
TRS6	At my school, employees have the opportunity to structure new knowledge
TRS7	At my school, employees have the ability to organize accumulated knowledge
TRS8	At my school, employees successfully combine existing knowledge with new insights
TRS9	At my school, employees are motivated to combine existing knowledge with new insights
TRS10	At my school, employees have time to combine existing knowledge with new insights
TRS11	At my school, the IT infrastructure makes it easy to combine existing knowledge with new insights
TRS12	At my school, the school headmaster/mistress provides employees with enough scope for development to use the aggregated information for experimenting with alternative solution possibilities
TRS13	At my school, employees are able to transform new knowledge in their work
TRS14	At my school, the school headmaster/mistress gives staff responsibility to lead transform new knowledge
TRS15	At my school, employees easily learn what is new in education management
TRS16	At my school, transformation of new knowledge gained is integrated in our daily work
Absorptive capacity: transformation	
EXP1	At my school, the school headmaster/mistress supports the use of new knowledge
EXP2	At my school, we use new knowledge to develop educational innovation
EXP3	At my school, the use of new knowledge has contributed to shaping a competitive advantage
EXP4	At my school, use of foreground contributes to effective usage of school resources
EXP5	At my school, the use of new knowledge has increased the number of students
EXP6	At my school, the use of new knowledge contributed to the expansion of the educational offer
EXP7	At my school, the use of new knowledge contributed to the improvement of students' external examination results
EXP8	At my school, using new knowledge contributed to the improvement of the quality of the school's work
EXP9	At my school, the use of new knowledge has contributed to improving customer satisfaction
EXP10	At my school, using new knowledge has contributed to improving our relationships with stakeholders
EXP11	At my school, the use of foreground contributed to develop the school's capabilities
EXP12	At my school, we use new knowledge to improve the functioning of the school
EXP13	At my school, we use new knowledge to analyze and monitor competitors' activities
EXP14	At my school, we regularly analyze procedures and adapt them to new knowledge
EXP15	At my school, using new knowledge helps to solve organizational problems
EXP16	At my school, the use of new knowledge allows us to react to changes in the environment
EXP17	At my school, the use of new knowledge allows you to improve your image

Notes: IT = Information technology; NGO = non-governmental organization

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