Using social media affordances to support Ill-structured problem-solving skills: considering possibilities and challenges

Adrie A. Koehler¹ · Daniela Rezende Vilarinho-Pereira¹

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Abstract

Educators consider the development of problem-solving skills in learners to be a primary goal of contemporary teaching and learning efforts. Yet, participating in problem-centered instruction is challenging for learners, and educators have sought different ways of supporting learners as they make sense of complex content. Social media applications are readily available for use by educators, which in turn provides many opportunities for these tools to support teaching and learning activities. While social media affordances offer educators exciting opportunities to support learners in authentic problem-solving contexts, these tools do not come without challenges, and little research has considered how such tools can specifically facilitate the development of learners' problem-solving abilities. The purpose of this paper is to identify prominent educational affordances of social media and to explore how these identified affordances have the potential to support ill-structured problem-solving activities. This paper offers researchers and educators new directions for facilitating problem-centered learning when using social media.

Keywords Educational affordances · Social media · Problem solving

Introduction

The potential of technology to enhance teaching and learning has long been debated as whether technologies fundamentally change teaching and learning processes (see Clark, 1983, 1994; Kozma, 1991, 1994). Arguably, technologies emerging and developing in the twenty-first century (e.g., social media) have evolved in profoundly different ways compared to previous technologies. Becker (2010) articulated the uniqueness of these evolutions: “The rate of change for newer, faster, and more ubiquitous ways to access communication technologies and the information now stored digitally continues to increase” (twenty-first century Clark section, para. 2). Simultaneously, the way individuals—especially youth—interact with technology as part of their daily routine has drastically changed (see Rideout et al.’s report from 2010).

✉ Adrie A. Koehler
adrie@purdue.edu

¹ Purdue University, West Lafayette, USA

Perhaps, social media represent one of the best examples of a technology that is “fundamentally different from, and more powerful than” previous technologies (Kaplan & Haenlein, 2010, p. 60). Social media applications offer individuals “new structures” to connect with people they “admire” or “find interesting” (Boyd, 2015, pp. 1–2). In short, “social media is a phenomenon” (Boyd, 2015, p. 1), and their emergence “enabled an evolutionary leap forward in the social component of web use” (Obar & Wildman, 2015, p. 745). While the specific properties of social media are not necessarily “new, their relation to one another because of networked publics creates new opportunities and challenges” (Boyd, 2014, p. 11).

To strategically consider how contemporary technologies, like social media, are evolving and to determine value, many researchers have adopted an affordance-based approach—both in education (Jin, 2018; Xue & Churchill, 2019; Zawawi et al., 2017) and beyond (Chen et al., 2019; van Osch & Coursaris, 2017). By focusing on affordances (e.g., qualities emerging from user and tool interaction, Gaver, 1991), not only are researchers able to consider the collection of features of a given tool to distinguish it from other tools (Treem & Leonardi, 2013), but also, educators can be informed in their technology integration decisions.

However, cognizant of Clark’s argument, technology advancement alone is not enough to generate educational transformation. Ideas of what comprises contemporary employability have also shifted (de Fruyt et al., 2015). That is, recently, individuals are increasingly expected to complete “non-routine and interactive tasks” versus “routine operations” in the workplace (Neubert et al., 2015, p. 238). While many skills are important for the twenty-first century workplace (e.g., creativity, collaboration, information literacy), problem solving is generally acknowledged “among the most meaningful and important kinds of learning and thinking” (Jonassen, 1997, p. 65). To prepare students for future professional ill-structured realities, educators have focused on facilitating “authentic and active” learning experiences (Tawfik et al., 2019).

Nevertheless, facilitating problem-solving skills is challenging, and during problem-centered learning experiences, the instructor bears much of the responsibility for guiding students to successful outcomes (Tawfik et al., 2020). Likewise, students face challenges while participating in problem-centered learning experiences (Koehler & Ertmer, 2016). Some educators have explored the use of technology to support students’ problem-solving skill development (Koehler et al., 2017; Goeze et al., 2014).

Although affordances of emerging technologies, like social media, and the facilitation of problem-solving skills have been previously researched, limited efforts have considered the integration of these two areas to offer new insight into successfully facilitating problem-centered methodologies. Therefore, the purpose of this paper is to explore how the affordances of a readily available and used technology like social media can support the problem-solving process. We first synthesize literature related to problem solving and social media affordances. Then, we provide specific strategies for facilitating problem-solving skills supported by social media affordances. We offer specific considerations necessary for intentional social media use during problem-center learning.

Problem solving

Problem-solving skills are generally recognized as an important outcome of twenty-first century education (Hesse et al., 2015; van Merriënboer, 2013). Problems are defined as situations “in which you are trying to reach some goal, and must find a means for getting there” (Chi & Glaser, 1985, p. 229) and are categorized in different ways to underscore

unique features (e.g., well-structured, ill-structured, story, design; Chi & Glaser, 1985; Jonassen, 1997, 2011). The ability to solve ill-structured problems is considered an “essential competence” by contemporary standards (Eichmann et al., 2019), and these problems have been conceptualized as having ill-defined parameters, inflexible constraints, and many possible solutions (Jonassen, 1997).

Although most educators agree the development of problem-solving skills is a worthwhile learning outcome, implementing methods promoting such skills can be challenging (Ertmer & Koehler, 2014; Koehler et al., 2019; Stepich et al., 2001). To conceptualize the problem-solving process and support the development of these skills, specific models have been proposed to describe the process used for solving ill-structured problems (see Choi & Lee, 2009; Jonassen, 1997; Svihla & Reeve, 2016). These models focus on key processes and behaviors taking place while problem solving: understanding problem situations and contexts, considering stakeholder perspectives, generating possible solutions, using a rationale to support decisions, and implementing and evaluating selected solutions.

Table 1 captures several conceptualizations of problem-solving processes. In these models, specific steps are articulated; however, while some phases must precede other phases for effective problem solving (e.g., problem representation before solution generation), problem-solving phases are generally considered iterative and non-sequential (Kim & Hannafin, 2011) and have traditionally been grouped into two primary categories by scholars: problem finding (e.g., developing a clear understanding of a problem) and generating solutions (e.g., creating solutions addressing defined problems) (Chi & Glaser, 1985; Ertmer & Stepich, 2005; Eseryel et al., 2011; Law et al., 2020). By synthesizing these models, problem finding comprises three primary actions: (a) articulating the problem space, constraints, and stakeholder roles; (b) considering diverse perspectives of stakeholders and their responsibilities; and (c) locating additional related information, resources, and tools that deepen understanding of the problem, context, and stakeholders. The generating solutions phase comprises (a) proposing potential solutions; (b) determining the value of a potential solution; (c) justifying, communicating, and presenting a specific solution; (d) implementing a selected solution; and (e) adapting a solution. Additionally, monitoring (e.g., reflecting on understanding to “develop arguments to support their mental model of the problem space,” Jonassen, 1997, p. 82) is a phase crossing both problem finding and solution generation.

Learner roles and challenges while problem solving

The problem-solving processes captured in the models cover what learners *should be completing* as they participate in problem-centered learning experiences. However, previous research suggests novices do not always achieve desired results, even in intentionally designed problem-centered learning (Ertmer & Koehler, 2015). For instance, novices commonly spend limited time understanding a problem, skipping to developing solutions (Koehler et al., 2019; Ng & Tan, 2006; Stepich & Ertmer, 2009), list known facts without synthesizing the information into primary issues (Ertmer & Stepich, 2005; Law et al., 2020), “take available information at face value” without considering underlying principles (Ertmer & Stepich, 2005, p. 40), and fail to recognize relationships among issues (Ertmer & Stepich, 2005; Law et al., 2020). Some of these challenges result from novices failing to see value in framing problems and their inexperience with this type of activity (Law et al., 2020; Svihla & Reeve, 2016).

Table 1 Ill-structured problem-solving models

Model	Steps
Jonassen (1997)	Articulate problem space and contextual constraints Identify and clarify alternative opinions, positions, and perspectives Generate possible problem solutions Assess the viability of alternative solutions by constructing arguments and articulating personal beliefs Monitor the problem space and solution options Implement and monitor the solution Adapt the solution
Ge & Land (2004)	Problem representation Generating or selecting solutions Making justifications Monitoring and evaluating
Choi and Lee (2009)	Understanding situations and contexts where multiple problems may exist Identifying problems by considering the multiple perspectives held by different stakeholders Generating possible solutions Choosing appropriate solutions with a rationale Implementing and evaluating the solutions
Kim and Hannafin (2011)	Identification Exploration Reconstruction Presentation communication Reflection negotiation
Svihla and Reeve (2016)	Problem framing Gather information Ideation Develop solutions Evaluation

When generating solutions, novices ignore given constraints (Ertmer & Koehler, 2014; Ertmer & Stepich, 2005), tend to solve problems in a single step (Ng & Tan, 2006), stick to solution strategies they are familiar with (Law et al., 2020; Ng & Tan, 2006), address the problem space more deeply with support from an active facilitator (Ertmer & Koehler, 2015), fail to recognize relationships among solutions (Ertmer & Stepich, 2005), and offer rigid solutions (Ertmer & Stepich, 2005). Primary factors preventing effective problem solving include an individual's "domain knowledge" and previous experience as expert "problem solvers have better developed problem schemas, which can be employed more automatically" (Jonassen, 2000, p. 69).

When regulating problem solving, learners experience challenges while both problem finding (e.g., fail to consider relationships, "prior knowledge," and "emerging problem

representations,” Law et al., 2020, p. 326) and generating solutions (e.g., adopt a linear approach to selecting a solution, Law et al., 2020). Finally, problem-centered learning is typically completed as a collaborative process, necessitating learners to develop skills in regulating the “collective activity” of the group (Häkkinen et al., 2017). As a result, collaboration can be challenging for learners as they struggle with managing differing perspectives and articulating a reasonable argument (Häkkinen et al., 2017; Koehler et al., 2020).

Facilitator role during problem-centered learning

Problem-centered methods (e.g., case-based learning, problem-based learning) can facilitate the development of problem-solving skills in learners (Koehler et al., 2019; Pease & Kuhn, 2011; Tawfik & Jonassen, 2013). In problem-centered learning, students analyze complex problems found in professional settings to gain vicarious experience (Stepich & Ertmer, 2009). To create an effective problem-centered learning experience, a facilitator’s ability to design, implement, and manage the learning experience (e.g., asking meaningful questions at the appropriate time) appears to be more influential than specific content expertise (Ertmer & Koehler, 2015; Leary et al., 2013). Implementing problem-centered methods is challenging for instructors as the facilitation process is non-linear and requires facilitators to provide an appropriate amount of support to learners (Ertmer & Koehler, 2014). However, effective facilitation of problem-centered learning includes: planning, implementing, and evaluating (Rico & Ertmer, 2015).

Facilitators must start with meaningful planning: selecting an appropriate problem or case on which to center the experience (Rico & Ertmer, 2015), mapping out the potential problem space (Ertmer & Koehler, 2014; Hmelo-Silver, 2013), crafting learning outcomes for the experience (Rico & Ertmer, 2015), and developing learning activities that prompt careful consideration of the problem under investigation (e.g., discussions, role-playing; Ertmer & Koehler, 2015; Rico & Ertmer, 2015). Additionally, as a collaborative experience, facilitators must intentionally structure groups and scaffold the subsequent collaboration (Häkkinen et al., 2017; Koehler et al., 2020).

At the core of problem-centered learning is collaboration occurring among learners and with the facilitator. Although intentional planning is necessary to establish the initial collaborative direction (Ertmer & Stepich, 2002; Kanuka, 2011), the facilitator must work in meaningful ways when the interaction is occurring to extend the problem space coverage (Ertmer & Koehler, 2015). Facilitators must manage the group’s collaboration, without dominating the conversation (Yew & Yong, 2014) and guide sensemaking through affirming ideas and prompting deeper consideration of key issues (Ertmer & Koehler, 2014, 2015; Yew & Yong, 2014). To bring closure to the learning experience, the facilitator should prompt students to share lessons learned relevant in future situations (Tawfik & Kolodner, 2016).

Finally, the facilitator is responsible for evaluating the resulting learning and developing measures representative of the problem-solving process (Jonassen, 2011). A combination of measures can provide a full consideration of a learning experience: peer evaluation forms for gauging collaboration, reflections and rubrics for self-assessment, mapped discussion of coverage of group interactions, and rubrics considering the development and quality of artifacts generated from the problem-solving experience (Ertmer & Koehler, 2014; Jonassen, 2011; Rico & Ertmer, 2015).

Educators use several strategies to support students’ problem-finding activities during problem-centered learning experiences: prompting students to consider problem elements,

constraints, and stakeholders via guided discussions (Ertmer & Koehler, 2014, 2015, 2018; Koehler et al., 2019); asking students to consider examples of ill-structured problems and share their own (Ng & Tan, 2006; Svihla & Reeve, 2016); providing learners opportunities to consider multiple perspectives (Ertmer & Koehler, 2014, 2015, 2018; Koehler et al., 2019; Svihla & Reeve, 2016); prompting students to ask questions related to the problems (Svihla & Reeve, 2016; Zydney, 2008); and stimulating learners' personal connections with authentic problems (e.g., working with a real client or considering a real-world problem; LaBanca & Ritchie, 2011; Svihla & Reeve, 2016).

When building learners' skills related to generating solutions, educators have used many methods: providing worked examples (Jonassen, 2011), using libraries of success and failure-based cases (Tawfik & Jonassen, 2013), suggesting and evaluating solutions through collaborative discussions (Ertmer & Koehler, 2014, 2015, 2018), using questioning and "reflective toss" to prompt deeper consideration (Hmelo-Silver & Barrows, 2006), requiring peer or expert review for evaluating solutions (Demiraslan Çevik et al., 2015; Verleger et al., 2016), and requiring learners to generate multiple solutions to a single problem (Ertmer et al., 2019).

Social media

Social media have become an important mediator of human experience, social interaction, and environmental realities (Deaton, 2015). In recent years, educators have increasingly explored social media as a tool to facilitate teaching and learning (Brown & Green, 2015; Dennen, 2018; Dennen & Rutledge, 2018), which has simultaneously stimulated researchers to investigate social media's role in teaching and learning (Raut & Patil, 2016; Selwyn & Stirling, 2016).

While no universally accepted definition of social media exists (Tess, 2013; Zhao et al., 2013), we define social media as internet-based technology supporting multimedia content (e.g., text, audio, video, still image, and animation) and interaction; includes synchronous (e.g., Zoom), semi-synchronous (e.g., WhatsApp), and asynchronous (e.g., discussion forums) communication; and promotes collaboration, information exchange, community formation, content creation, and self-expression (Boyd, 2014; Dennen, 2018; Zhao et al., 2013). Through mobile devices, people can use social media anytime and anywhere (Page, 2012). Greenhow and Lewin (2016) suggest social media have three typical features: (a) they highlight individual preferences and activity through profile pages; (b) they allow connections among users, between users and information, and between users and locations to be seen (e.g., checking into a location), and (c) they can be updated "dynamically" with embedded content (e.g., videos).

Some examples of social media include social networking sites (e.g., Facebook), blogs (e.g., WordPress), microblogs (e.g., Twitter), wikis (e.g., PBworks), social bookmarking and tagging (e.g., Diigo), media sharing (e.g., YouTube), electronic notepads (e.g., Evernote), collaborative word processing (e.g., Google Docs), idea management and mapping (e.g., Wridea), and animation tools (e.g., PowToon) (Koehler & Ertmer, 2016; Koehler et al., 2017; Scott et al., 2016). Social media tools are constantly being created and evolving (Boyd, 2014; Obar & Wildman, 2015; Tess, 2013). With several social media tools available, educators have many potential options for developing new skills and knowledge (Reiser, 2018).

To identify prominent literature on social media in educational contexts, we considered research published in top instructional design journals focused on learning experiences

including social media as a key part of the process. This allowed us to capture the results of research related to the *intentional* use of social media to support instructional efforts and therefore, communicate the potential for individuals interested in using these tools to support the development of problem-solving skills in similar learning experiences. See Table 2 for an overview of findings from highlighted social media research.

Challenges with integrating social media for educational purposes

Believing social media automatically improves education is misleading. Simultaneously, blaming social media for all problems of humanity is inaccurate. These extreme approaches to social media “assume that technologies possess intrinsic powers that affect all people in all situations the same way” (Boyd, 2014, p. 15). However, technology’s “pros and cons” create a complex interaction between people and social media (Boyd, 2014, p. 16). In educational settings, teachers must be aware of the benefits of each technology, as well as the disadvantages, as their use can create challenges for parents, educators, and scholars (Boyd, 2014).

First, social media feeds are constantly updated with member activity. This intense flow of messages, photos, videos, and links can be overwhelming for learners, leading to cognitive overload (see Hsu, 2015; Huang et al., 2013; Yen et al., 2015). Cognitive overload can especially be an issue when using social media to solve complex problems (Koehler et al., 2017). Second, learners using social media must discern quality as they locate information. Social media amplify the circulation of “misinformation (inaccurate information) and disinformation (deceptive information)” (Karvola & Fisher 2013, para. 1). Social media users can find “too much information, and (...) irrelevant, conflicting, outdated, and non-credible information” (Sin, 2016, p. 1794). As social media have shifted the role of users from consumers to producers of knowledge (Obar & Wildman, 2015), anyone can create content for self-seeking purposes. Students from middle school to college have difficulty determining the credibility of information shared online (McGrew et al., 2017).

Third, instructional social media use may lead to distractions for learners (e.g., students check Facebook notifications during class, Fried, 2008). Multitasking behavior is detrimental to students’ learning processes (Demirbilek & Talan, 2018; Karpinski et al., 2013; van der Schuur et al., 2015), as they attempt to engage with course and non-course-related activities simultaneously and increase their cognitive load (Kirschner & van Merriënboer, 2013). Fourth, integrating social media for educational purposes creates challenges with managing boundaries between personal and formal spaces, specifically regarding student-instructor relationships (McEwan, 2012). Although social media offer instructors and students opportunities to build relationships, maintaining privacy is important (Owen & Zwahr-Castro, 2007). As social media preserve interactions and shared information (Boyd & Ellison, 2008), political views, religious beliefs, and personal activities potentially become available to an entire class, leading to feelings of confusion, discomfort, and embarrassment (McEwan, 2012; Owen & Zwahr-Castro, 2007). The blurry boundaries between what is private and public on social media can also create serious professional consequences for teachers exhibiting behavior deemed as inappropriate (e.g., posting pictures while holding a gun, Koehler & Besser, 2020).

Fifth, research suggests that social media use can have negative effects on users’ self-esteem, leading to depressive tendencies (Ozimek & Bierhoff, 2020). As young people view idealized representations of others’ lives on social media, they make comparisons to their own lives, leading to decreased self-esteem in some instances (Steinsbekk et al.,

Table 2 Description of social media articles

Social media	Study purpose	Methods	Key findings
Content Acquisition Podcasts (Kennedy et al., 2014)	“Extend a program of research regarding a multimedia-based instructional tool called Content Acquisition Podcasts (CAPs)” (p. 117)	<i>Quantitative</i> 164 preservice teachers enrolled in an introductory course in special education The experimental group received instructions using CAPs, and the control group had access to textbooks, a graphic organizer, and outline of main content	When comparing the posttest of the two groups, the participants in the experimental group (Course Content Area 1: $M=12.4$, $SD=1.89$; Course Content Area 2: $M=13.9$ $SD= .99$) achieved significantly higher scores than the participants from the control group (Course Content Area 1: $M=10.2$, $SD=2.15$; Course Content Area 2: $M=12.0$ $SD=1.98$). Course Content Area 1: $F(1,156)=43.10$, $p>.001$, $d=1.09$ and Core Course Content Area 2: $F(1,150)=57.61$, $p>.000$, $d=1.21$, suggesting that CAPs supported preservice teacher learning content about key course topics.
Facebook (Stewart & Gachago, 2016)	Investigate how a digital storytelling activity conducted in a private Facebook group influenced students’ “critical awareness and social consciousness regarding notions of ‘self’ and ‘other’” (p. 528)	<i>Qualitative</i> 25 American undergraduate students and approximately 40 South African undergraduate students	The use of Facebook for digital storytelling allowed students from both countries to overcome the stereotypes they had about each other as they recognized similarities between them, created an opportunity for friendships, provided a space for students to post their opinions regarding social and political topics, and stimulated students to include emotion in their stories.

Table 2 (continued)

Social media	Study purpose	Methods	Key findings
Discussion Forums (Tan, 2017)	Investigate the interactions among students from a writing class in an online discussion forum while completing a paraphrasing assignment	<i>Qualitative</i> 43 English as a second language undergraduate students from a Malaysian university	The use of discussion forums to complete the paraphrasing assignment allowed students to share their answers, comment on classmates' contributions and receive comments, reflect upon feedback, and present what they learned, reposting their answers with corrections—promoting self-directed and self-regulated behaviors. Through these interactions, most students provided interpretations and suggestions regarding classmates' paraphrasing and evaluated the content, vocabulary, and grammar.
Podcasts (Naseri & Mortalibzadeh, 2016)	Investigate the effects of listening to podcasts compared to listening to a radio program on students' self-regulation and their perception of the use of podcasts for educational purposes	<i>Mixed Methods</i> 54 female, English as a foreign language (EFL) students from an Iranian language institute The experimental group listened to podcasts, and the control group listened to radio programs After listening to either the podcast or radio program, both groups transcribed it, summarized it, and discussed it with the whole class	The use of podcasts showed a positive effect on students' self-regulation. When comparing the posttests of these two groups, the participants in the experimental group achieved significantly higher scores than the participants from the control group, $t(52) = 3.45$; $p = .001$, suggesting that the podcast had a greater effect on EFL students' self-regulation. The results also showed that the students who listened to the podcasts had positive perceptions of the use of podcasts for educational purposes.

Table 2 (continued)

Social media	Study purpose	Methods	Key findings
Mobile Messaging (Lee & Kim, 2016)	Investigate the effect of Kakao-Talk, a mobile messaging tool, on students' English writing (sentences with to-verb), when used outside of the classroom to extend in-class activities and explore the effects of Kakao-Talk on students' affective domains	<i>Mixed Methods</i> 62 undergraduate students from a South Korean university	The use of Kakao-Talk improved writing with the to-verb of students with a low level of English proficiency. The results showed significantly higher posttest scores ($M = 32.79$, $SD = 9.82$) in comparison with pretest scores ($M = 18.24$, $SD = 11.11$). Participating in the activities via Kakao-Talk also allowed students to create a sense of presence, providing them with different challenges, and a feeling of efficacy.
Vlogs (Debbag & Fidan, 2021)	Investigate the effectiveness of educational Vlogs on the motivational beliefs of trainee teachers	<i>Mixed Methods</i> 56 trainee teachers from a Turkish university The experimental group created Vlog reflections of their practicum experiences, and the control group reflected by creating written reports	The use of Vlogs showed a positive effect on the sub-factors of trainee teachers' motivational beliefs. The participants in the experimental group achieved significantly higher scores on the posttest than the participants from the control group for intrinsic goal orientation ($U = 72.0$, $z = -5.24$, $p < .05$, $r = -.70$), task value ($U = 111.0$, $z = -4.57$, $p < .05$, $r = -.61$), control beliefs ($U = 108.0$, $z = -4.64$, $p < .05$, $r = -.62$), self-efficacy ($U = 92.0$, $z = -4.89$, $p < .05$, $r = -.65$), and lower scores for extrinsic goal orientation ($U = 178.5$, $z = -3.47$, $p < .05$, $r = -.46$). Participants from the experimental group identified benefits (e.g., self-regulation and interaction) and challenges (e.g., technical problems and time-consuming) of using Vlogs.

Table 2 (continued)

* A search was conducted on the Academic Search Premier, Education Full Text, Education Source, ERIC, PsychINFO databases. We used the descriptors ("web 2.0" OR wikis OR blogs OR "electronic discussion groups" OR podcasting OR "social media") AND TX (method*) AND (results OR findings) AND (participants OR subjects OR learners). The search was limited to articles published between 2014 and 2021 and the top 10 journals in instructional design based on the impact factor of 2019. After reviewing the abstracts of the 167 articles, 38 articles were selected for in-depth analysis based on research studies of social media use in K-12, undergraduate, and graduate educational settings. Results revealed the use of social media to support a variety of purposes including writing skills (e.g., Lee & Kim, 2016; Lin, 2015; O'Byrne & Murrell, 2014; Tan, 2017; Thomas, 2017; Xie & Lin, 2016); content acquisition (e.g., Forbes & Khoo, 2015; Kennedy et al., 2014); knowledge or language acquisition (e.g., Altanopoulou, Tselios, Katsanos, Georgoutsou, & Panagiotaki, 2015; Çetinkaya & Sütçü, 2018; Huang et al., 2014; Resendes et al., 2015; Voroble et al., 2021); usability and accessibility of technology (e.g., Gachago et al., 2016); collaborative learning and sense of community (e.g., Asoodar et al., 2014; Biasutti, 2017; DeWitt et al., 2017; Fraj-Andrés et al., 2020; Kuo, Belland, & Kuo, 2017; Sun et al., 2018; Zhang et al., 2021); interaction and learning within a community (e.g., Borge et al., 2020; Guiterrez-Santiuste & Gallego-Arrufat, 2014; Lee & Bonk, 2016; Ricoy & Feliz, 2016; Wu & Nian, 2021); problem-based learning (e.g., Chu et al., 2017; Ioannou et al., 2015; Lau et al., 2017); cultural critical awareness and social consciousness (e.g., Chuang, 2016; Stewart & Gachago, 2016); career skills (e.g., Rutten et al., 2016); motivational beliefs (Debbag & Fidan, 2021); twenty-first century competence (Sevilla-Pavón, 2019); and higher order cognitive thinking (e.g., Hou et al., 2020; Wu, 2020); self-regulation (e.g., Naseri & Motalebzadeh, 2016; Yeo & Lee, 2014). Of these articles, the details of five are shared in this table

2021). Finally, teachers' beliefs influence their intention to use (Sadaf et al., 2012; Teo, 2009) and integrate (Li et al., 2019; Teo et al., 2008) educational technology. If educators perceive the barriers to implementing social media (e.g., academic dishonesty, class disruptions, cyberbullying, O'Bannon & Thomas, 2014) to be greater than potential benefits, they are unlikely to integrate social media for educational purposes.

Educational affordances of social media

Social media applications are constantly being created, updated, and discontinued (Denen, 2018). Although educators have many options when designing learning experiences, selecting the most appropriate tool can be challenging if teachers focus on each property of a given tool and miss a clear connection to their context or audience. To overcome these challenges, an alternative approach is to focus on the affordances of a given technology. Broadly, affordances have been conceptualized as "relations between the abilities of organisms and features of the environment" (Chemero, 2003, p. 189).

Considering the definition of affordance more deeply reveals that affordances for an object vary depending on the organism involved and a given environment: for example, a rock can provide shelter to an ant or serve as a weapon for humans (Gibson, 1986). Therefore, affordances are not "properties" of a given environment, but rather the relationships among these different components determine the affordances for an object in a specific situation (Chemero, 2003). According to Greeno (1994),

Gibson's intention was that the affordance is a property of whatever the person interacts with, but to be in the category of properties we call affordances, it has to be a property that interacts with a property of an agent in such a way that an activity can be supported. (p. 340)

Greeno used the term *ability* to indicate "whatever it is about the agent that contributes to the kind of interaction that occurs" (p. 340), discussed the intrinsic relationship between affordances and abilities, and believed establishing an affordance without determining the ability of the agent interacting with the environment is not possible. Additionally, he argued, "an ability depends on the context of environmental characteristics, or that an affordance depends on the context of an agent's characteristics" (Greeno, 1994, p. 340). Therefore, suggesting a car affords driving is inappropriate as this affordance exists in relation to a person who knows how to drive. For individuals lacking the ability to drive, cars do not afford driving but might afford transportation.

Finally, affordances are not dependent on the agent's perception of the affordance or motivation to engage in an activity (Gibson, 1986; Greeno, 1994). Using social media as an example, Twitter affords publicity to musicians and connections between graduate students and scholars worldwide. Assuming both musicians and graduate students can write, they might use other tools (e.g., Microsoft Word) to compose songs and dissertations. The fact that a musician does not identify Twitter as a medium to publicize their new album or chooses not to publicize it on Twitter does not mean Twitter does not afford the singer publicity. However, if the singer chooses Microsoft Word to publicize their new album, publicity is unlikely because this tool does not afford publicity.

Considering social media affordances used by teachers and students in educational settings allows these agents to move past individual applications to focus on utility to consider and accomplish instructional goals. Across literature on social media for educational

Table 3 Articulated social media affordances

Source	Affordances	Context	Tool(s)
Treem and Leonardi (2013)	Visibility Editability Persistence Association	Organizational communication	Social Media (blogs, wikis, social networking Applications, social tagging, and microblogging)
Boyd (2014)	Persistence Visibility Spreadability Searchability	Networked public / general use	Social Network Sites
Rice et al. (2017)	Pervasiveness Editability Self-presentation Searchability Visibility Awareness	Organizational communication	Information and communication technologies (ICTs)—computer conferencing systems, online bulletin boards, e-mail, group support systems, voice mail, intranets, videoconferencing, virtual collaboration, texting, mobile phones, and social media. (organizational media)
Jim (2017)	A casual space with easy access to native speakers of Chinese Authentic meaning-focused communication with native speakers of Chinese Linguistic resources and multiliteracies Space for new identity creation	Chinese as a second language	WeChat
Sutcliffe et al. (2011)	Direct social cues (social awareness, feedback, prompts) Structures (representations and content, profiles, blogs, wikis) Communication and Functions (communication, coordination, task support)	Motivational studies	Social mediating technologies: Facebook, Wikipedia, Blacksburg Electronic Village, and World of Warcraft

Table 3 (continued)

Source	Affordances	Context	Tool(s)
Xue and Churchill, (2019)	Resources Sharing Authentic Learning Collaboration Community Building Motivating Environment Evaluation and Feedback Administration for Learning	Educational context	WeChat
Manca and Ranieri, (2013, 2016)	Mixing Information and Learning Resources Hybridization of Expertise Widening Context of Learning	Technology-enhanced learning environment	Facebook

Table 4 Comparison of social media affordances across different applications

Social Media	Affordance			
	Association	Visibility	Persistence & Searchability	Identity
Wiki	Contributions are tracked to specific users Image, videos, information, etc. from diverse sources can be used (and linked) to construct pages Individuals can comment on pages Individuals can share a link to a page with others	Revision history of edits and contributors Interactions among users in comments Notifications of updates	Page creation history is saved Wiki content is arranged in pages and is searchable	Individuals can create a profile with personal picture and details Individuals can use different tools to construct content Individuals determine how they would like to contribute to the collaborative group product
Blog	Posts are attributed to author Image, videos, information, etc. from diverse sources can be used to construct pages Individuals can comment on posts Posts can be shared by others or linked to other sites	Posts include author information with a timestamp Interactions among users in comments Notifications when someone comments	Content is maintained in reverse chronological order Posts can be searched	Individuals can create a profile with personal picture and details Individuals can use different tools to construct content
Instagram	Posts are attributed to author Users can share images or videos created by self or others Users can tag others in the posts that they create Users can comment on others' posts Users can share others' posts and profiles within or outside the application Users can follow others and allow others to follow them	Posts include author information with a timestamp Interactions among users in comments Notifications when someone comments, tags, or likes a post Receive follow suggestions See comments on others' posts See others' followers and who they are following See posts that friends were tagged in by others View activity log of personal use	Posts are maintained in chronological order Content generated is searchable Stories can be archived and viewed as memories Search for the profiles of others	Individuals can create a profile with picture and personal details; website and bio Individuals determine what groups and public figures to follow Individuals have control over who they follow and who they allow to follow them Individuals can use different tools to construct content

Table 4 (continued)

Social Media Affordance		Association	Visibility	Persistence & Searchability	Identity
Snapchat		Picture or video content is created by users and shared with others or to a personal story	Snaps include a timestamp See the number of snaps sent and received by users	Snaps can be saved to memories and within personal chats with others Memories can be searched by date Search for the profiles of others	Individuals can create a profile with personal pictures and video details Individuals can use different tools to construct content Individuals determine what groups and public figures to follow Individuals have control over who they friend and get notifications from Individuals can use different tools to construct content
		Users can reply to messages or comment on stories	Share and request locations See shared content that has been saved by friends		
		Users can share the stories of others	Receive notifications when others update their stories, send messages, replay snaps, or screen capture content		
		Users can follow others and allow others to follow them	See if and when users open sent content View the amount of time spent on the application		
Facebook		Users can create content (e.g., picture, video, text) or share content created by others on the site or outside of the site	Posts include author information with a timestamp Interactions among users in comments	Individual activity is maintained in a personal timeline Timelines can be searched Memories of past activity are sent to user Search for the profiles of others	Individuals can create a profile with picture and personal details: employment, education, religious and political beliefs, personal websites, family members and relationship information, quotes, interests Individuals determine what groups to join and what public figures to follow Individuals have control over who they friend and get notifications from Individuals can use different tools to construct content
		Users can tag others in the posts that they create	Notifications when someone comments, tags, or reacts to a post		
		Users can comment on others' posts	Receive friend suggestions		
		Users can follow others and allow others to follow them	See comments on others' posts See others' friends See posts that friends were tagged in by others See activity updates from friends Check into locations and see the locations of friends View activity log of personal use See members of groups Invite friends to like groups		

and communicative purposes, we located articles that articulated and defined specific affordances of social media versus talking about them in general ways (See Table 3). For instance, Xue and Churchill (2019) completed a systematic literature review related to the educational use of WeChat and analyzed the results section to identify specific educational affordances. In another instance, Rice et al. (2017) used prior research to create labels for and define social media affordances and then surveyed participants on their potential use.

From selected articles, we studied and compared descriptions of different prominent affordances and grouped recurring ideas. Then, we noted any affordance identified at least three times across articles. From this examination process, we identified five prominent affordances: association, visibility, persistence, searchability, and identity creation. Across different social media applications, these affordances are embodied in different ways (see Table 4). We provide a definition of each affordance, consideration of how previous educational social media research relates to the defined affordance, and connections between each affordance and potential support for problem-centered learning.

Association

Social media afford learners opportunities to connect or associate with other individuals or information (Jin, 2018; Koehler et al., 2017; Manca & Ranieri, 2016; Tur & Urbina, 2014; Xue & Churchill, 2019). These connections and associations can potentially take many forms: interactions and collaborations between learners and others (e.g., peers, instructors, experts) and between learners and diverse contexts (e.g., informal, non-native); educational resource sharing in diverse and integrated formats (e.g., integration of platforms in one place—YouTube shared via Facebook for discussion); and interactions and resources shared with enhanced connections (e.g., geotagged photos can be located and discussed). While on the surface connecting learners to others and information does not seem novel, the way social media can potentially facilitate these interactions offers unique opportunities for negotiating learning experiences.

First, social media offer educators and learners ways to connect with authentic contexts (e.g., communicating with native speakers when learning a new language, Jin, 2018; Xue & Churchill, 2019), informal learning environments (e.g., connecting instructors and students through more casual means—news sources, podcasts, etc., Xue & Churchill, 2019), geographically separated experiences (e.g., “providing a Google Maps link to the actual location of the recorded event,” Cochrane & Bateman, 2010, p. 6), and hybridized expertise (e.g., contributions “of current and past learners, practicing professionals and other teachers, can encourage the development of social capital,” Manca & Ranieri, 2016, p. 504). Through these connections, experiences are not limited to the classroom, and learners’ awareness increases (e.g., language, resources, terminology, digital competence, Tur & Urbina, 2014). Second, many applications (e.g., Google Suite) allow users to invite contacts to collaborate (Zawawi et al., 2017) and support simultaneous access of resources and information to co-create and revise (e.g., collaborating via Google Doc, Bower, 2016). Collaboration via social media is also enhanced by combining information with learning resources: mixing “instructional material with information and knowledge sources that, produced elsewhere and available through several channels, influence the design and the delivery of the learning experience” (Manca & Ranieri, 2016, p. 504). Third, connections and associations via social media occur immediately (Xue & Churchill, 2019), with ease (with limited effort users can “spread information, whether by explicitly or implicitly encouraging the sharing of links,” Boyd, 2014, p. 12), and in many different formats (e.g.,

text, video, audio, Bower, 2016), at diverse times (e.g., a synchronous online meeting versus analyzing an asynchronous image in a discussion forum, Bower, 2016), and directly or indirectly (e.g., “directly via IM and e-mail plus interaction via avatars and indirectly through individual profiles,” Sutcliffe et al., 2011, p. 1056). Finally, the potential of amplification of associations, interactions, and connections is great when using social media due to openness and mass sharing: recording and broadcasting live events, using QR codes to connect to information, and creating RSS feeds (Bower, 2016; Tur & Urbina, 2014).

Association and the problem-solving process

The association afforded through social media creates formal and informal interactions among learners and with the facilitator during problem-centered learning. Perhaps, the most enhancing aspect of the association afforded through social media is the expansion beyond the classroom to offer learners and facilitators options for supporting and supplementing problem-centered learning experiences.

Problem finding To articulate the problem space more effectively, both facilitators and learners can associate with others and information in strategic ways. For instance, as a common challenge for novice problem solvers is having limited experience with a problem context (Law et al., 2020), social media can situate a context to promote understanding constraints and stakeholder roles. Moghavvemi et al. (2018) found business students indicated they use YouTube for academic and work purposes (e.g., “to solve problems,” answer questions, “learn new things”), while Yildirim (2019) found that a Facebook group offered opportunities to math teachers for professional development (e.g., resources and instructional strategies, feedback on posed challenges, and brainstorming on teaching). Either through self-directed or instructor-facilitated methods, learners have access to a variety of resources, both human and informational, created by professional organizations, experts, news organizations, peers, and so on. These associations can help shape learners’ understanding of a problem space by more deeply understanding constraints, stakeholder roles, and diverse perspectives.

Solution generation Association through social media provides learners new ways to propose and justify solutions and determine the value of a given solution, specifically through gaining alternative viewpoints and critical views from those with which they are interacting. For instance, Chen and Luh (2018) required industrial design students to upload sketches of their assignments to Facebook to gain feedback from not only peers but all their connections. Learners required to upload their work for a broader discussion achieved higher exam scores compared to the control group not using social media. Within a classroom setting, social media can “blend learning in an informal setting outside school” (Lau et al., 2017, p. 548). For instance, elementary learners in Lau et al.’s (2017) research indicated a wiki allowed them to extend their face-to-face connections with peers while collaborating. Similarly, a group of pre-service teachers used Google Docs to manage group collaborations while creating instructional solutions (Koehler et al., 2017).

Visibility

Social media offer individuals the chance to make visible “behaviors, knowledge, preferences, and communication network connections” (Treem & Leonardi, 2013, p. 150).

For instance, when using social media, individuals can “view the number of likes, comments and shared links within each post” (Zawawi et al., 2017, p. 437), observe “activity of individuals, what they are doing, and the groups they belong to” (Sutcliffe et al., 2011, p. 1056), and track revisions made while creating content (Koehler et al., 2017; Sutcliffe et al., 2011)—gaining insight into peers’ participation. In addition, social media display connections that would take more effort to uncover (e.g., “Geo-tag original photos,” Cochrane & Bateman, 2010, p. 5). By seeing the “network diagrams, lists, maps, and other visualizations,” social media users can use these elements to inform how they connect and behave (Sutcliffe et al., 2011, p. 1054).

Visibility through social media is distinguished from other tool use and non-technology situations in multiple ways. First, the visibility of users’ behaviors and activities on social media has greater potential reach (Boyd, 2014). That is, in non-social media situations, while individuals may be aware of the actions of others, social media afford users insight into what is going on with someone with which no recent physical contact has been made or individuals with no existing relationship. At the same time, this visibility of user activity is automatic, as a function of the social media application (e.g., notifications of users’ activities or updates pushed to the feeds of other users, Rice et al., 2017), often unintentional (e.g., “interactions are often public by default, private through effort,” Boyd, 2014, p. 12), and influenced by previous use and interests (e.g., information customized based on user preference, Shane-Simpson et al., 2018, suggested connections or content based and use, Sutcliffe et al., 2011).

Visibility and the problem-solving process

Through social media, learners can use visibility to monitor their problem-finding and generating-solution efforts more closely. Learners can individually track their actions and progress or use cues from peers’ actions to consider different approaches and ideas. Collaboratively, learners can consider the building of ideas or group effectiveness. Across these instances, facilitators have access to individual and group processes that would otherwise be more difficult to uncover. This information can be useful for providing tailored support (e.g., just-in-time scaffolding) and assessments (e.g., considering growth and contributions).

Problem finding To assist with effective problem finding, visibility allows users to investigate a problem in intentional ways. After completing a business communication course focused on developing students’ social media networking skills (e.g., development of a personal learning network), students developed confidence to “research and find potential networking contacts” and introduce themselves “to someone in their network” (Anders, 2018). Additionally, within their class, these learners valued considering peers’ perspectives: “If they perceived another student as particularly credible or offering particularly relevant experience, they would seek out and read their blog posts” (p. 24). In both instances, the visibility afforded by the social media applications allowed the students to seek intentional connections and information to support their own development. Similar strategies could be applied to understand a problem space more deeply (e.g., contacting experts based on their activity to consider constraints and diverse perspectives; comparing how peers defined a problem to inform individual understanding).

Solution generation As learners develop and consider solutions in problem-centered learning environments, visibility offers insight into how their peers are completing the process. For instance, undergraduate students enrolled in an ESL course used online discussion forums to develop their paraphrasing skills. From the visibility afforded from the discussions, learners could observe how their peers were learning writing skills: “Students witnessed peer modeling of not only paraphrasing but also reviewing of other students’ responses” (Tan, 2017, p. 1247). Reflecting on the visible behaviors, learners can build on their own ideas, leading to more effective solutions. In wikis, learners can collaboratively generate solutions, view a record of contributions, and revert to a previous version (Chu et al., 2017).

Preservation and searchability

Although preservation and searchability represent unique affordances, their close relationship makes considering what one offers without the other difficult. When individuals use social media, the content they generate or their communication with others “remains accessible in the same form” after any behavior or interaction has concluded (Treem & Leonardi, 2013, p. 155). As a result, social media offer users ways to keep a record of previous communication, content generation, interactions, and conversations. Because of this preservation, social media simultaneously affords searchability: “any inquisitive onlooker can query databases and uncover countless messages written by and about others” (Boyd, 2014, p. 12). For instance, social media preserve activity in many ways: communication forums organized by threads offer “reflective discussion and debate” (p. 772) that can be revisited following an asynchronous conversation, and repositories can be created to store and organize content (e.g., videos, images; Bower, 2016). This preservation creates a chronological record that can be shared to widen associations, searched to locate pertinent information for a given learning task, and explored to identify individuals that could lead to meaningful connections (Bower, 2016; Sutcliffe et al., 2011). Beyond promoting collaborative opportunities, content preserved via social media offers individual support during teaching and learning by providing a “digital trail of students’ thought processes that [enable] students to draw on peers’ ideas and critique in their explorative discovery processes” (Rambe, 2012, p. 140).

The preservation afforded by social media “enables interactions to take place over time in an asynchronous fashion” (Boyd, 2014, p. 11). While the preservation generated from social media use is linked to the individuals directly interacting, the availability of the preservation is widespread, largely because of searchability. For instance, while an e-mail conversation between two friends could be printed or forwarded to others, by default, the interaction is limited to only these individuals. However, many social media applications preserve interactions for individuals not directly involved with the initial act and allow both the creator and others to search the communication (e.g., Facebook affords users the option of searching other users’ timeline activity). Additionally, in another form of preservation, some social media applications share “memories” with users reminding them of previous activity (e.g., pictures, conversations).

Preservation, searchability, and the problem-solving process

As a result of preservation and searchability, learners can access, save, and tag resources to support problem solving and search social media applications later to revisit the desired

information. These affordances are especially useful for supporting a digital schema of experiences and reflection, a key aspect of the problem-solving process. Additionally, instructors can take a closer look at the ideas being contributed to assess student progress and their own efforts in facilitating problem-centered learning experiences.

Problem finding From preservation and searchability, learners can consider how others have defined and approached similar or related problems to the one with which they are interacting. Li et al. (2017) investigated LinkedIn users' approaches to solving technical problems with laptops. Findings revealed users participated in a collaborative process of posing a problem, proposing ideas, discussing the value of proposed ideas, and finally, trying out different options. Learners have access to these preserved conversations and can essentially use these to inform their own understanding of the problem being investigated. In short, preserved, searchability conversations like this can serve as a case library in a sense, which can be an effective support for learners during problem-centered learning (see Tawfik & Jonassen, 2013). Yeo and Lee (2013) explored the use of blogs by elementary students to manage personal information. Some learners were able to locate, classify, and save digital resources not only for the immediate task but future tasks too. A similar approach can be useful for students in a problem-centered learning experience to help shape their developing problem-finding skills.

Solution generation Unlike a face-to-face conversation, conversations via many social media applications (e.g., Facebook timeline, blog comments) can be revisited and used to improve future problem-solving efforts. For instance, learners participating in an online, case-based learning experience shared they revisited discussion posts multiple times, including observing the interactions and feedback between peers' they admired and others and between the facilitator and peers to shape their future case analyses and discussion participation (Koehler et al., 2020). As part of their research to understand the role of blogs in supporting information technology students' learning, Asoodar et al. (2014) analyzed students' comments posted on blogs, group chats, and forum entries to determine their level of cognitive engagement. As learners have access to the same records, they could review their blog activities, as related to a problem-solving activity, to self-evaluate their performance.

Identity creation

A key aspect of using social media requires users to create a profile including self-generated content, as well as information developed by others (Ellison & Boyd, 2013). Through profile creation and personal and collaborative use, a specific identity is created. Social media provide a collective environment of experience sharing where learners can interact with instructors, peers, and personal contacts to create strong bonds (Bower, 2016; Jin, 2018; Manca & Ranieri, 2016; Sutcliffe et al., 2011; Xue & Churchill, 2019; Zawawi et al., 2017). While cultivating a community using social media, instructors and learners have the opportunity to craft their identities as relevant to the learning task at hand (e.g., "a competent Chinese language user rather than merely a beginning-level learner," Jin, 2018, p. 44) and in a safe space (e.g., "democratised communication" so students can voice concerns with the learning experience, Rambe, 2012, p. 140). Additionally, while generating social media content to prompt or demonstrate understanding and sensemaking, educators and learners can assume many different roles (Bower, 2016; Koehler et al., 2017; Sutcliffe

et al., 2011; Xue & Churchill, 2019; Zawawi et al., 2017). With several options, both educators and learners can select tools aligned to a personal style to meet learning goals.

In social media communities, interactions and learning experiences can be co-managed through the use of notifications (Cochrane & Bateman, 2010; Xue & Churchill, 2019; Zawawi et al., 2017), and knowledge and skill acquisition can be co-evaluated through instructor and peer feedback (Cochrane & Bateman, 2010). As all these experiences take place in a community environment, they *can* offer an atmosphere of support leading to meaningful learning (Rambe, 2012; Zawawi et al., 2017) and a wider learning context “where learners and instructors share personal and professional interests and aspirations, thus mixing different contexts of learning and social and personal life” (Manca & Ranieri, 2016, p. 504).

Identity creation and the problem-solving process

Learners are not always prepared to participate in student-centered learning experiences (Koehler et al., 2020; Parkes et al., 2015). Additionally, social media offer learners the opportunity to craft an intentional identity situated in a specific learning experience: “Networked learning and ‘networking to learn’ helped students see themselves as professionals and helped them take a more self-directed and professional approach to learning” (Anders, 2018, p. 23). That is, with facilitator guidance, learners can create an identity allowing them to intentionally participate in a problem-centered learning experience as they problem find and generate solutions.

Problem finding Svihla and Reeve (2016) argue, “in order for activities such as information gathering, ideation, and evaluation to constitute problem framing, the designer must take ownership of the problem.” By crafting a specific identity as a problem framer when using social media, learners can increase intentionality to enhance problem solving. At the beginning of a problem-centered program or course, learners can be guided to use social bookmarking tools, RSS readers, and blogs focused on emerging industry topics and strategies to inform their developing knowledge base (Koehler & Ertmer, 2016). Through these efforts, learners realize their interests, identify areas for growth, and shape a digital identity.

Solution generation When creating solutions, learners can decide the specific identity they would like to assume as they collect data from peers and generate content (Bower, 2016), research existing resources individually before sharing (Zawawi et al., 2017), collaboratively construct an artifact with peers (Bower, 2016), and integrate multiple tools to manage a single learning goal (Bower, 2016; Zawawi et al., 2017). Research suggests that blogs implemented for instructional purposes can provide “a supportive environment in which critique, comment and constructive feedback” can take place (Garcia et al., 2015, p. 887). By completing these activities, learners gain practice with participating in collaborative activities—experiences likely representative of learners’ future professional endeavors.

Supporting problem solving using social media affordances

Educators and researchers should consider shifting focus from selecting specific technologies and instead identify relevant affordances that align well with specific problem-solving activities. By focusing first on the problem-centered learning environment and the specific

roles of the facilitator and learners, instructors can then consider how affordances best serve instructional purposes, expand the learning experience beyond classroom walls, and benefit from the experiences, expertise, and interaction from others (see Fig. 1).

Affordance-supported problem finding and solution generation

To support problem finding and generating solutions, educators must first consider activities offering students practice with some or all phases of the problem-solving process. For instance, case-based instruction (CBI) offers learners the opportunity to independently analyze real-world problems before working “collaboratively to clarify and extend individual interpretations” (Ertmer & Koehler, 2015, pp. 69–70), commonly involves collaborative discussions to support sensemaking (Ertmer & Koehler, 2015, 2018; Koehler & Ertmer, 2016), and prompts learners to reflect on the analysis process (Koehler et al., 2019). Next, educators must consider how learners will engage with specific problem-solving phases during the selected instructional approach.

As previously discussed, when targeting problem finding, a common strategy educators use is prompting learners to consider and share examples of complex problems related to the problem under investigation (Ng & Tan, 2006; Svihla & Reeve, 2016), and one strategy commonly used to address generating solutions include expert or peer reviewing solutions (Demiraslan Çevik et al., 2016). After identifying activities to engage learners with targeted problem-solving phases, educators can identify affordances to enhance the learning experience (See Table 5). Finally, educators should consider how the specific affordance is embodied across different social media applications and select an application best serving the specific learning goal. Simultaneously, educators must consider the potential negative effects of using the selected social media application as part of the process and proactively address potential problems as much as possible.

The examples provided in Table 6 illustrate two different approaches to using affordances to support problem-solving skills during CBI. For instance, the problem-finding activity illustrates how the affordances of a single social media application (e.g., Facebook) enhance an instructional activity (e.g., considering problems related to ones in the case); while the solution-generation activity shows how several different social media tools (e.g., LinkedIn, Piktochart, Facebook, Google Docs, blogs, and wikis) can support a single instructional activity (e.g., peer and expert review). On one hand, limiting the number of social media applications involved while facilitating CBI seems reasonable; including one or two applications can reduce confusion and the cognitive load of students and instructors already dealing with complex topics.

On the other hand, using several tools may allow for instructors and learners to reach more creative outcomes, as each affordance is not equivalent across applications. For instance, the visibility afforded through Facebook allows users to see what their friends have shared, liked, and commented on, but it does not offer users access to a revision history of collaboratively generated work, as a wiki would. Therefore, when designing activities and selecting affordances to support instructional goals, educators must be mindful of how specific affordances are embodied in a given application to best serve their needs. Additionally, certain affordances lend themselves to specific instructional activities. For example, as social media afford preservation of content by allowing individuals to revisit previous interactions and content generation, reflective activities where instructors and learners can identify strengths, weaknesses, missed content, and growth are readily

Fig. 1 Considerations for implementing social media into problem-centered learning environments

Table 5 Affordance-based opportunities for supporting problem solving

Social media affordance	Opportunities for supporting problem finding	Opportunities for supporting generating solutions	Opportunities for supporting monitoring
Association	<p>Articulating the problem space, constraints, and stakeholder roles</p> <p>Conversing with experts regarding topics related to the problem under investigation</p> <p>Asking learners to share examples of and personal experiences with similar problems</p> <p>Considering diverse perspectives of stakeholders</p> <p>Reviewing profiles of individuals in professional roles similar to those present in the problem-centered experience (through both student-led and instructor-led activities)</p> <p>Providing multiple resources related to the problem being considered in different formats and from different sources in a common space (through both student-led and instructor-led activities)</p> <p>Locating additional information, resources and tools</p> <p>Exposing learners to more perspectives and diverse ideas when exploring problem components (through both student-led and instructor-led activities)</p> <p>Joining online communities where professional lingo is being used and problems of practice are being considered</p>	<p>Proposing potential solutions</p> <p>Considering solutions of similar problems covered in social media sources by reputable sources</p> <p>Reviewing recommendations in online communities for managing common constraints for a given problem or industry (through both student-led and instructor-led activities)</p> <p>Consulting peers and experts when generating solutions</p> <p>Determining the value of a potential solution</p> <p>Asking peers and experts to review proposed solutions</p> <p>Justifying, communicating, and presenting a specific solution</p> <p>Presenting proposed solutions to individuals in roles connected to the problem</p> <p>Prompting learners to share examples of similar problems they solved with pros and cons</p> <p>Implementing and adapting a selected solution</p> <p>Growing relationships with community partners where solutions can be tested (through both student-led and instructor-led activities)</p> <p>Connecting student groups located in a geographically diverse location considering potential solutions</p>	<p>Connecting with professionals to examine their problem finding and generating solutions techniques to create a comparative reflection to personal efforts</p> <p>Using trending topics and resources related to a problem context and locating experts content experts to shape understanding of industry norms and professional goals</p>

Table 5 (continued)

Social media affordance	Opportunities for supporting problem finding	Opportunities for supporting generating solutions	Opportunities for supporting monitoring
Visibility	<p>Articulating the problem space, constraints, and stakeholder roles</p> <p>Selecting peers with which to work or creating groups based on social media behavior in order to articulate a problem space</p> <p>Reviewing social media activity, individually, in groups, and led by the facilitator, to identify relationships among topics discussed and participant contributions related to problem finding</p> <p>Prompting students to collaboratively consider details from individual problem representations synthesize ideas</p> <p>Considering diverse perspectives of stakeholders</p> <p>Connecting with professionals in roles similar to those as stakeholders in the problem under consideration to observe behaviors</p> <p>Locating additional information, resources and tools</p> <p>Selecting resources relevant to the problem under investigation based on the activities of others</p>	<p>Proposing potential solutions</p> <p>determining the value of a potential solution</p> <p>Selecting peers with which to work or creating groups based on social media behavior in order to generate solutions</p> <p>Reviewing social media activity individually, in groups, and led by the facilitator, to identify relationships among topics discussed and participant contributions related to generating solutions</p> <p>Justifying, communicating, and presenting a specific solution</p> <p>Rating proposed solutions using liking and commenting features</p> <p>Implementing and adapting a selected solution</p> <p>Self-monitoring effectiveness of implemented solutions and using data to revise</p>	<p>Using likes, comments, and votes to check understanding or to gain a sense of group problem representation and solution generation</p> <p>Considering revision history to evaluate individual contributions to problem representation and solution generation</p> <p>Reflecting on a chronological revision history of constructing problem representation to more deeply understanding the complete process</p> <p>Reflecting on a chronological revision history of constructing, justifying, and evaluating solutions to more deeply understanding the complete process</p>

Table 5 (continued)

Social media affordance	Opportunities for supporting problem finding	Opportunities for supporting generating solutions	Opportunities for supporting monitoring
Preservation & searchability	<p>Articulating the problem space, constraints, and stakeholder roles</p> <p>Reviewing previously generated content to locate individuals that can be supportive during problem representation</p> <p>Prompting learners to revisit previous problem finding content that was generated to inform current problem finding</p> <p>Considering diverse perspectives of stakeholders</p> <p>Using archived resources to investigate stakeholder perspectives</p> <p>Searching content generated by experts in similar roles as those in the problem under consideration</p> <p>Locating additional information, resources and tools</p> <p>Locating organizational and expert resources related to a given problem context</p>	<p>Proposing potential solutions</p> <p>Prompting students to revisit solutions to inform current solution generation</p> <p>Reviewing previously generated content to locate individuals that can be supportive during generating solutions</p> <p>Determining the value of a potential solution</p> <p>Comparing individually proposed solutions with archived solutions of similar or related problems</p> <p>Prompting learners to analyze archived previous solutions</p> <p>Justifying, communicating, and presenting a specific solution</p> <p>Using archived resources to support proposed solutions</p> <p>Implementing and adapting a selected solution</p> <p>Capturing implementation of a solution to examine effectiveness and make adjustments</p>	<p>Tracking and comparing problem representations and solutions across multiple learning experiences (from both student and facilitator perspectives)</p> <p>Investigating individual and group growth with problem 1) identification and consideration and 2) solution generation, justification, and evaluation (from both student and facilitator perspectives)</p> <p>Guiding individual and group reflection of problem finding and solution generation</p> <p>Creating a personal repository of relevant problems and solutions to use for future reference</p>

Table 5 (continued)

Social media affordance	Opportunities for supporting problem finding	Opportunities for supporting generating solutions	Opportunities for supporting monitoring
Identity creation	<p>Articulating the problem space, constraints, and stakeholder roles</p> <p>Requiring learners to lead communications related to problem space articulation</p> <p>Providing learners multiple options for communicating stakeholder roles and perspectives, constraints, and related content</p> <p>Prompting learners to visually represent the relationship among complex problem components</p> <p>Considering diverse perspectives of stakeholders</p> <p>Revising problem conceptualization after receiving feedback from peers and/or the facilitator</p> <p>Co-constructing with peers a representation of a stakeholder perspectives, problem tasks, or constraints</p> <p>Sharing ownership between instructors and students with communication structure when considering problem elements</p> <p>Asking students to embrace different creative roles while constructing an understanding of problem elements</p> <p>Offering opportunities for learners to discuss personal reactions to problem elements and reflect on feelings related to the problem</p> <p>Locating additional information, resources and tools</p> <p>Requiring students to collect data, explore additional resources, and use multiple tools to convey understanding of a problem being considered</p>	<p>Proposing potential solutions</p> <p>Requiring learners to lead communications related to generating solutions, evaluating, and justifying solutions</p> <p>Determining the Value of a Potential Solution</p> <p>Offering opportunities to learners to discuss personal reactions to potential solutions and reflect on feelings related to different solution paths</p> <p>Justifying, communicating, and presenting a specific solution</p> <p>Sharing ownership between instructors and students with communication structure when developing solutions</p> <p>Providing learners multiple options for presenting proposed solutions, pros/cons of a given solution, and offering feedback to peers</p> <p>Prompting learners to visually represent the relationship among solutions</p> <p>Co-constructing and co-presenting with peers potential solutions and evaluations of proposed solutions</p> <p>Asking students to embrace different creative roles while generating and vetting solutions</p> <p>Implementing and adapting a selected solution</p> <p>Developing a prototype of a proposed solution</p> <p>Requiring students to collect data, explore additional resources, and use multiple tools to convey understanding of a multiple potential solutions</p>	<p>Using notifications to track individual and group progress of ideas and collaborations related to problem finding</p> <p>Guiding learners to craft identities as problem finders</p> <p>Guiding learners to craft identities as generating and vetting solutions</p> <p>Using notifications to track individual and group progress of ideas and collaborations related to generating, evaluating, and justifying solutions</p>

Table 6 Overview of targeted problem-solving activities enhanced during CBI by social media affordances

	Targeted problem-finding activity: <i>Examples of complex problems related to the problem being investigated in the case</i>	Targeted solution generation activity: <i>Peer reviewing proposed case solutions</i>
Association	Creating a Facebook discussion where each learner posts a resource covering a problem element present in the case under investigation such as a news article, a podcast, YouTube video, or other content for the group to consider	Asking learners to identify and connect with individuals with expertise in content being covered in the case via LinkedIn in order to review proposed solutions
Visibility	Asking learners to vote (via “liking”) on the resources shared that were most helpful for understanding the case and to vote on case problem conceptualizations that they deemed most accurate	Requiring learners and reviewers to complete the peer review process using Google Docs so that a complete revision history and comments is available for consideration
Preservation & searchability	Prompting learners to review discussion threads to individually review and reflect upon how the shared examples led to the final conceptualizations of problem elements present in the case and to identify problem areas that need further consideration in the case	Learners review peer review resources, conversations, and feedback to create a blog reflection on how the peer review process evolved, contributed to understanding the case, created challenges, and can improve personal problem solving
Identity creation	Grouping learners into new Facebook discussion threads where they can synthesize common elements from the problems they individually shared in order to present a cohesive overview of common problem elements, constraints, and relationships across shared resources with connections made directly to the case under investigation	After receiving feedback on proposed case solutions from peers and experts, learners can create an infographic using Piktochart to synthesize the type of feedback they received and a plan for addressing suggestions and developing needed skills to be successful in the future

supported. Similarly, social media applications affording strong visibility allow instructors and students opportunities to assess learning outcomes.

Finally, an important part of the problem-solving process is monitoring one's current understanding. The specific affordances available through social media allow learners to monitor their participation in problem-centered learning experiences in ways that would otherwise be much more difficult. That is, learners have countless opportunities to connect with individuals and content to serve their individual needs and goals, select appropriate applications to express understanding, locate individuals within the community to gain individualized support, and review previous contributions and activities to gain a sense of understanding.

As educators make decisions regarding integrating social media into problem-centered learning, focusing on affordances provides a new way of selecting tools meeting educational goals. Using this approach, educators can be informed as to how best support and enhance targeted problem-solving activities.

Conclusion

Educators are increasingly using social media applications successfully to achieve diverse learning goals. While supporting the development of problem-solving skills in learners using technology is not a new approach, social media offer new and exciting opportunities to educators looking to engage learners as they analyze complex problems of practice. To boost chances of success when facilitating problem-solving skills, educators should be intentional with integrating social media into teaching and learning activities: By selecting an effective problem-centered approach, targeting a problem-solving phase(s) paired with a meaningful strategy, identifying social media affordances that support the selected strategy, and considering challenges with the selected social media and the role others can play in the process, learners' problem finding, solution generation, and monitoring can be supported in meaningful ways.

More research is needed to explore the possibilities of implementing social media to support and enhance problem-centered learning experiences. Arguably, many more effective examples exist in the literature than are efficiently located. For instance, as learners are developing their language skills or drafting industrial design drawings, these illustrate specific examples of problem solving. However, the skills being targeted in these investigations are not labeled in this way. Additionally, to explore the impact of affordance-based approaches on learners' problem-solving skill development, researchers should compare environments enhanced with social media affordances with other types of support (e.g., non-digital scaffolds, other technologies) and consider how different affordances support specific types of problem-solving behaviors. More research is also needed to examine how educators make decisions around selecting social media affordances while managing challenges when supporting problem solving and to investigate how to best support and train educators to successfully use social media affordances to support the development of problem-solving skills.

As with other innovations, the emergence of social media has come with specific challenges. Arguably, many of these challenges result from users' inability to effectively manage the power resulting from social media affordances. Although educators must be mindful of the challenges inherent to integrating social media, social media afford possibilities worthy of investigation: association, visibility, preservation, searchability, and identity

creation. By implementing these tools as part of the problem-solving process, instructors can simultaneously help learners develop their digital literacy skills to be successful users of social media for academic purposes and to effectively navigate their future personal and professional lives.

Declarations

Conflict of interest We are unaware of any conflicts of interests related to completing this research.

Ethical standard We did not collect human data as part of this research and complied with appropriate ethical standards.

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Adrie A. Koehler is Assistant Professor of Learning Design and Technology at Purdue University. Her research interests include improving the transition of pre-service teachers into the education profession, using emerging technologies for instructional purposes, and facilitating problem-centered learning.

Daniela Rezende Vilarinho-Pereira is a doctoral student in Learning Design and Technology at Purdue University. Her research interests include investigating the role of digital technology in creativity development, student motivation and academic engagement, and talent development.