ISTITUTO NAZIONALE DOCUMENTAZIONE INNOVAZIONE RICERCA EDUCATIVA

MESE 1
Measurement in STEM Education (MESE1)
Naples, 30-31 January, 1 February

DISP Dipartimento di Scienze Politiche Università degli studi di Napoli Federico II

FISICA "ETTORE PANCINI"

Why does Integrated STEM education (still) does not fit

Pinpointing the breaking points

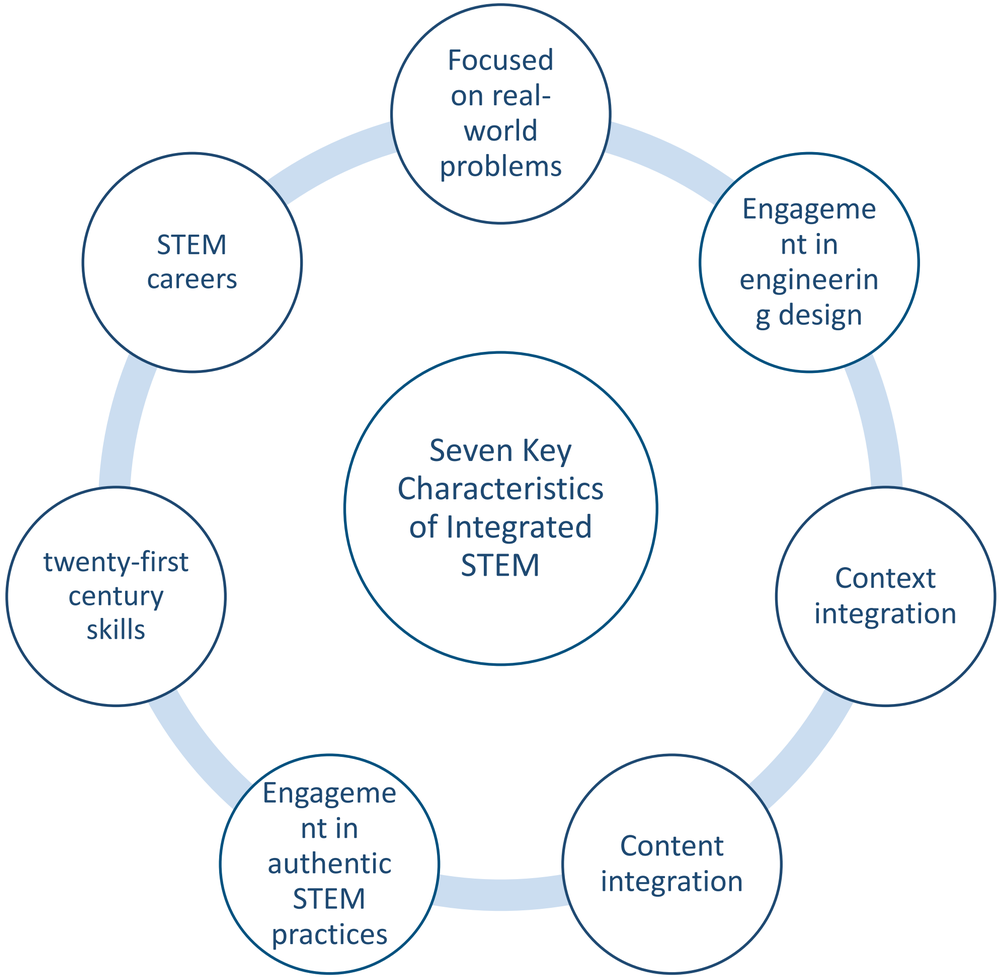
Sede legale in Firenze:
via M. Buonarroti, 10
50122 Firenze
Tel. Centralino: +39 055 2380301
www.indire.it

Jessica Niewint-Gori, INDIRE

Policy Maker	• Guidelines, Funding, Training
Territory	• Curricular and non-curricular activities, Projects, Training
School	• Leadership, Space, Time, Training
Teacher	• Methodologies, Training, Subject, Programme
Student	• Aptitudes, Potentials, Skills, Knowledge
STEM	• Technology, Transdisciplinary, Real-world challenges

Seven Key Characteristics of Integrated STEM

- Focused on real-world problems
- Engagement in engineering design
- Context integration
- Content integration
- Engagement in authentic STEM practices
- Twenty-first century skills
- STEM careers



Roehrig et al. 2021

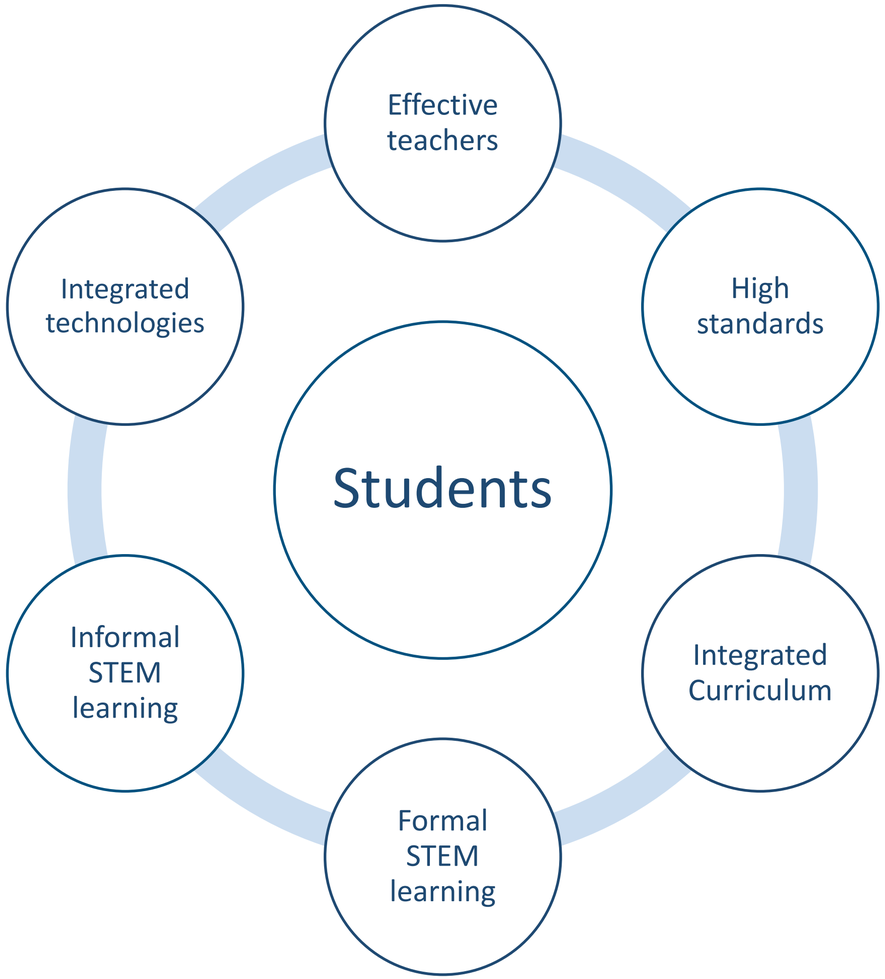
Key elements of effective STEM programmes

- Effective teachers
- High standards

  science and engineering practices;

  cross-cutting concepts;

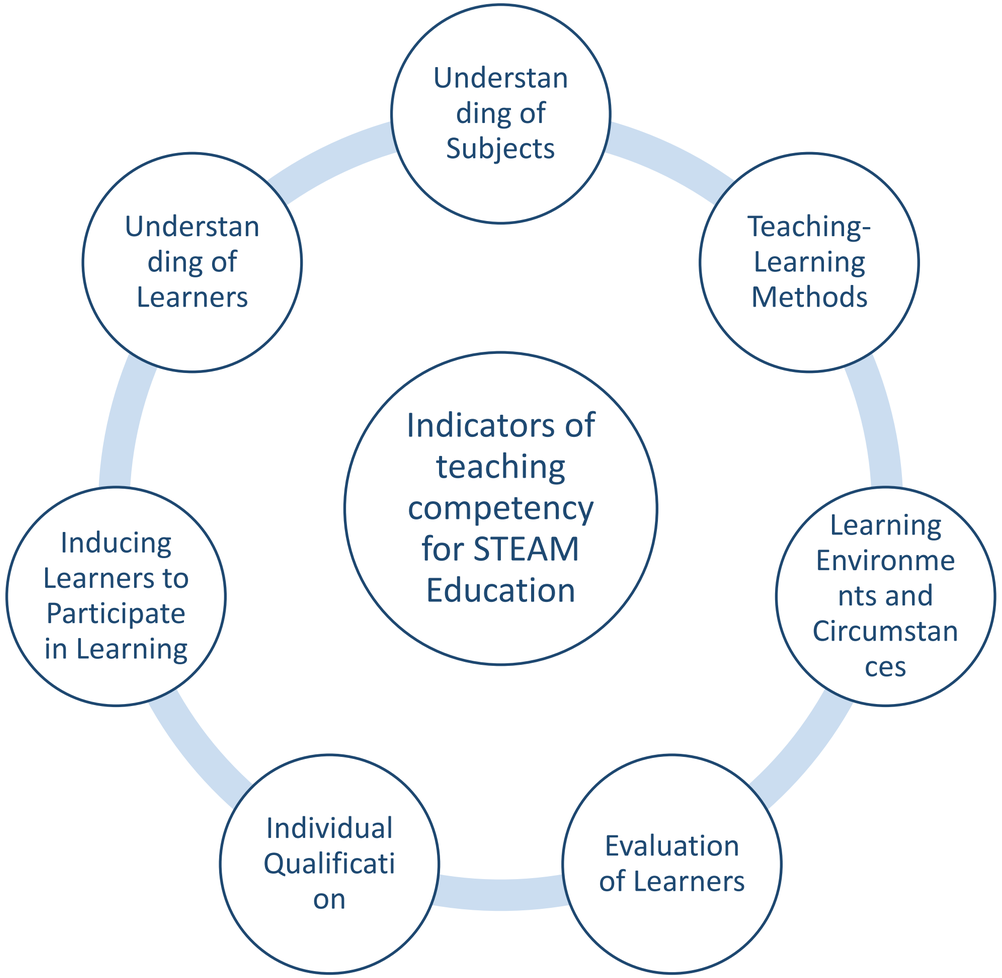
  fundamental ideas of discipline areas and their applications in reality.
- Integrated Curriculum
- Formal STEM learning
- Informal STEM learning
- Integrated technologies



(Yoder et al., 2016)

Indicators of teaching competency for STEAM Education

- Understanding of Subjects
- Teaching-Learning Methods
- Learning Environments and Circumstances
- Evaluation of Learners
- Individual Qualification
- Inducing Learners to Participate in Learning
- Understanding of Learners



(Kim & Kim 2016)

Important elements for professional development for STEM education

- Active learning
- Consistency with guidelines and curriculum
- Accompaniment - Extended duration
- Focus on learning new skills in the context of building content knowledge
- Collective participation

(Johnson & Sondergeld, 2015)

TEACHERS

	Helpful	Harmful
Internal	**Strengths** Collaboration between teachers in different STEM disciplines, catalyzes self-efficacy positively	**Weaknesses** Radical shift needed in established instructional practice Lack of discipline/content knowledge
External	**Opportunities** Professional development programs available Participatory pedagogical design	**Threats** Lack of quality resources and curriculum materials School environment and administration

Tasiopoulou et al. (2020)

POLICY MAKERS

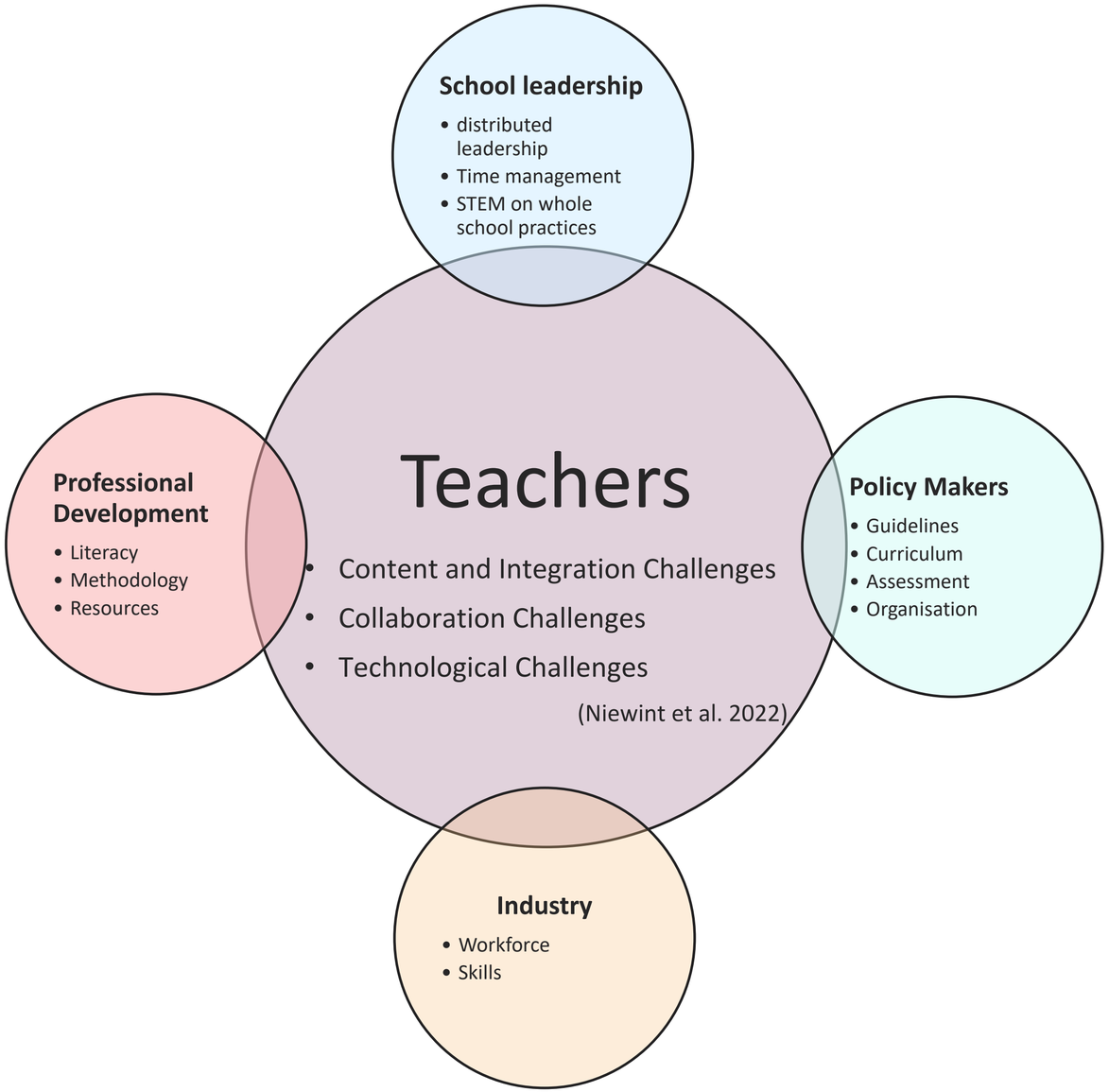
	Helpful	Harmful
Internal	**Strengths** Awareness [recent reforms advocate for integrating STEM]	**Weaknesses** Segregated and discipline-based structure [silos] STEM = Science & Mathematics
External	**Opportunities** New technologies in the classroom like robotics automatically connect more disciplines and methodologies like project/problem based learning	**Threats** Lack of standard assessment tools and methodologies “how did we know that they know ?” Teachers’ believe “topics like energy (physics) are more STEM than others”

Tasiopoulou et al. (2020)

INDUSTRY

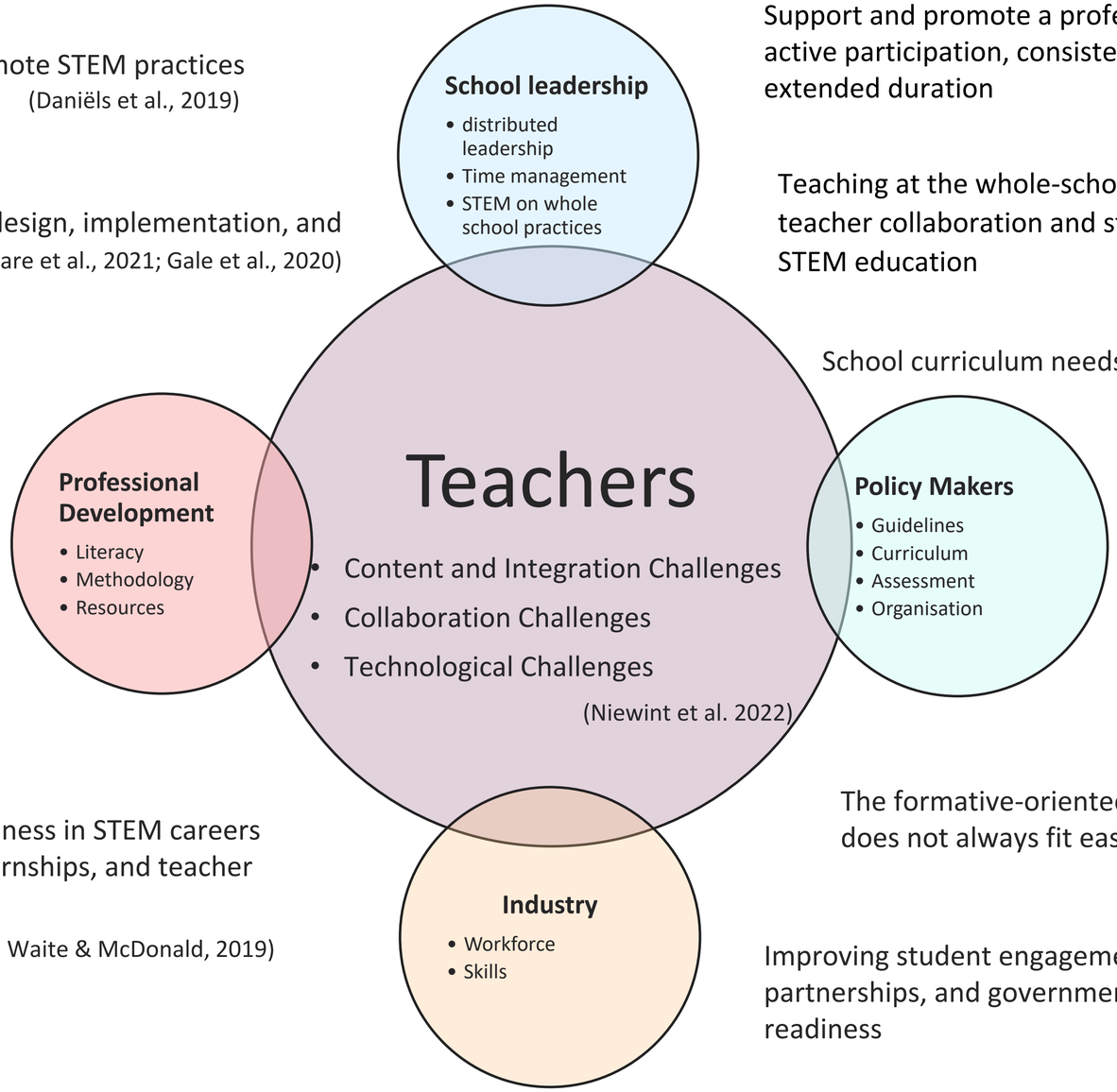
	Helpful	Harmful
Internal	**Strengths** Workforce - STEM education develops knowledge and skills	**Weaknesses** Crucial information about STEM careers is lacking
External	**Opportunities** Teacher Training - The industry is engaged in developing learning programes in STEM	**Threats** Initiatives to promote STEM not systematically connected to the curriculum Programmes aligned to the main function of the provider

Tasiopoulou et al. (2020)


School leadership
• distributed leadership
• Time management
• STEM on whole school practices
Professional Development
• Literacy
• Methodology
• Resources
Teachers
• Content and Integration Challenges
• Collaboration Challenges
• Technological Challenges
(Niewint et al. 2022)
Policy Makers
• Guidelines
• Curriculum
• Assessment
• Organisation
Industry
• Workforce
• Skills

Shift to distributed leadership to support and promote STEM practices (Daniëls et al., 2019)

Teachers need to be trained in STEM pedagogical design, implementation, and evaluation (Brown & Bogiages, 2019; Dare et al., 2021; Gale et al., 2020)



Support and promote a professional development with collective and active participation, consistent with the guidelines and curriculum of an extended duration (Johnson & Sondergeld, 2016)

Teaching at the whole-school level could enable teacher collaboration and stakeholder engagement in STEM education (Leung, 2020)

School curriculum needs to be ready to promote an integrated STEM approach (Daniëls et al., 2019)

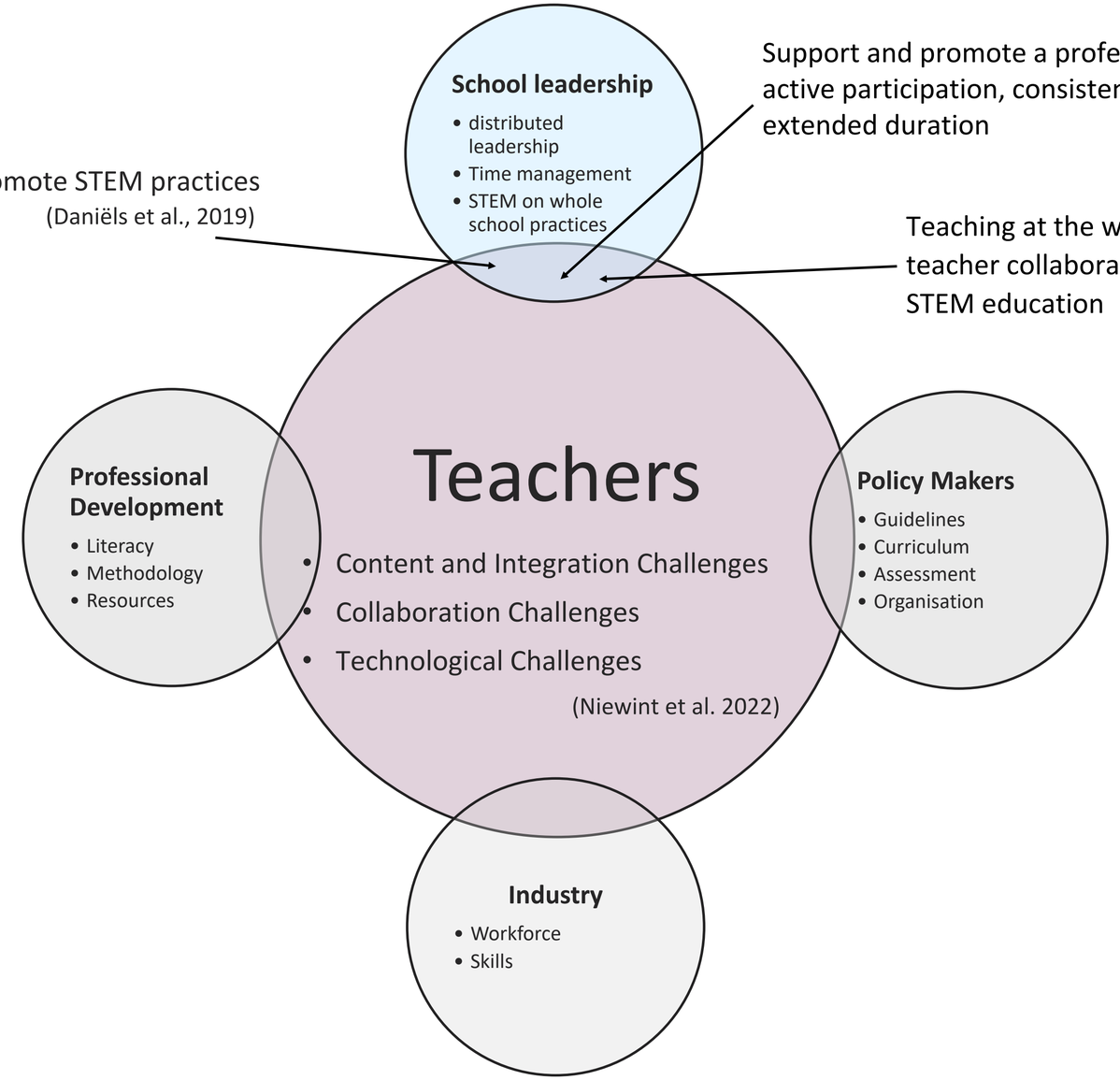
STEM professional development programs need to provide opportunities for peer collaboration (Balgobal, 2020; Dong et al., 2020; Wang et al., 2020)

Raise career awareness and readiness in STEM careers through exploration, student internships, and teacher externships (Ainslie & Huffman, 2019; Waite & McDonald, 2019)

The formative-oriented integrated STEM approach which does not always fit easily into the curriculum (Ryu et al., 2019)

Improving student engagement through education business partnerships, and government policy to enhance career readiness (Ainslie & Huffman, 2019)

Shift to distributed leadership to support and promote STEM practices
(Daniëls et al., 2019)



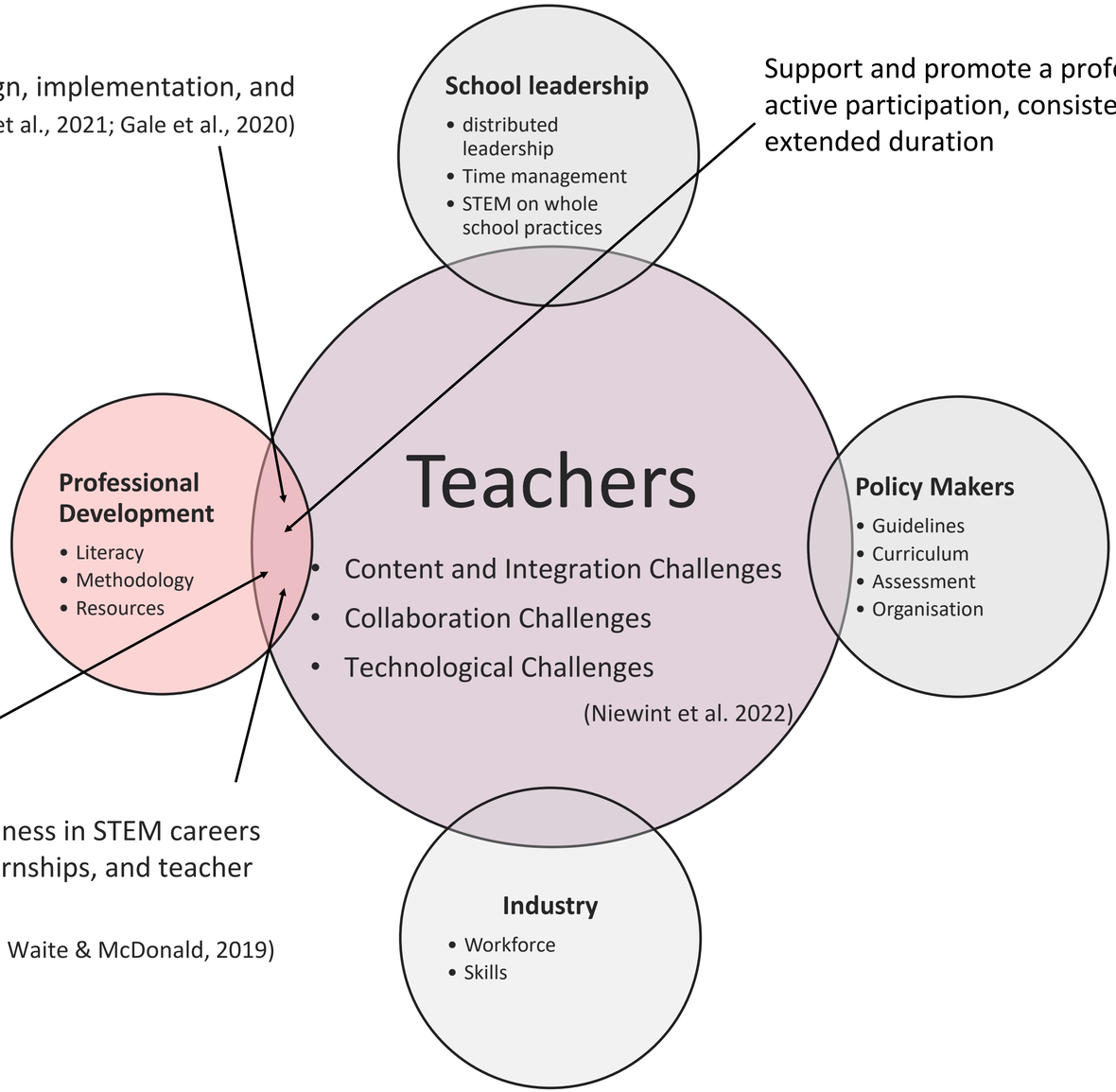
Support and promote a professional development with collective and active participation, consistent with the guidelines and curriculum of an extended duration
(Johnson & Sondergeld, 2016)

Teaching at the whole-school level could enable teacher collaboration and stakeholder engagement in STEM education
(Leung, 2020)

Teachers need to be trained in STEM pedagogical design, implementation, and evaluation (Brown & Bogiages, 2019; Dare et al., 2021; Gale et al., 2020)

Support and promote a professional development with collective and active participation, consistent with the guidelines and curriculum of an extended duration

(Johnson & Sondergeld, 2016)

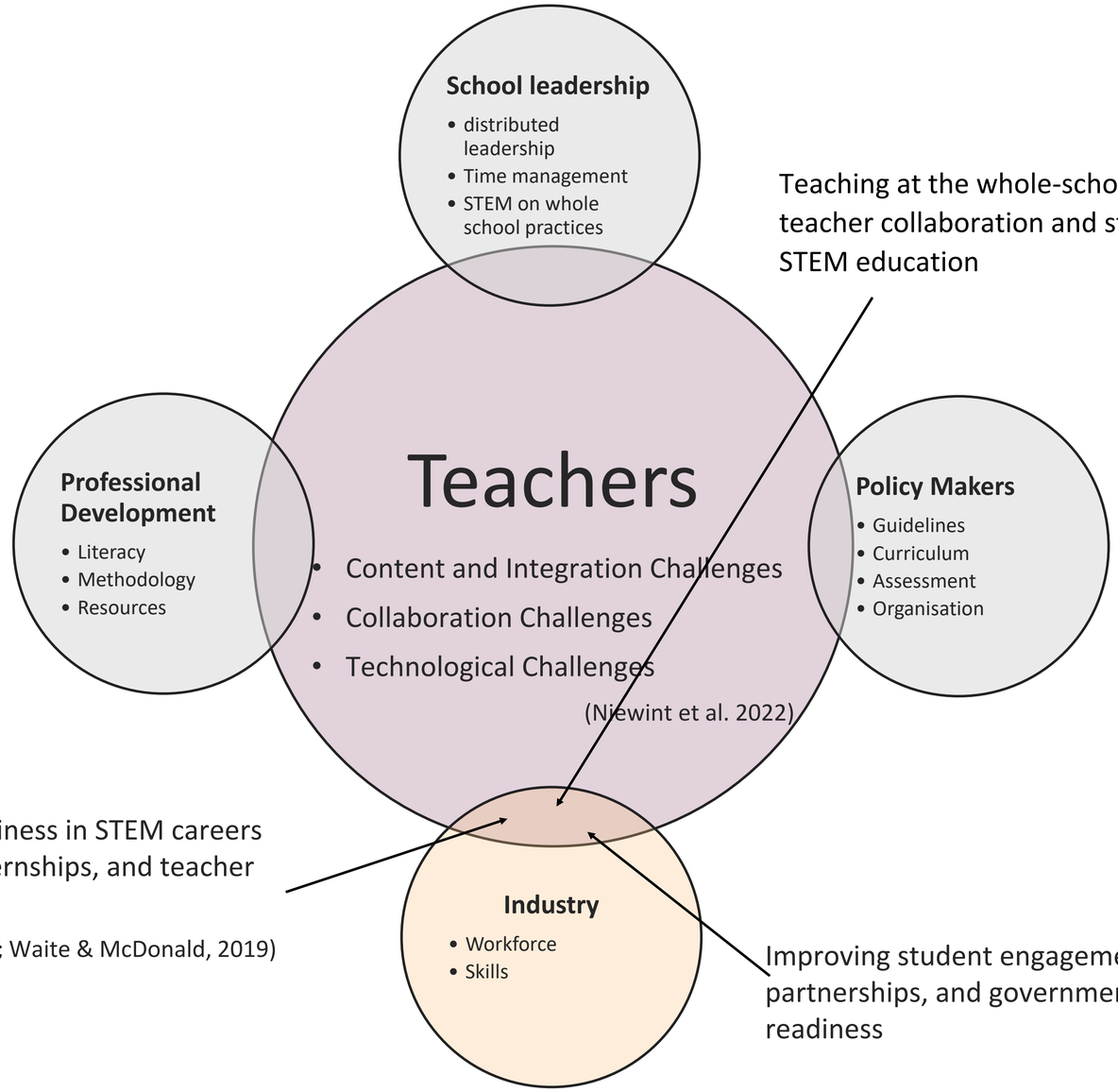


STEM professional development programs need to provide opportunities for peer collaboration

(Balgobal, 2020; Dong et al., 2020; Wang et al., 2020)

Raise career awareness and readiness in STEM careers through exploration, student internships, and teacher externships

(Ainslie & Huffman, 2019; Waite & McDonald, 2019)



Teaching at the whole-school level could enable teacher collaboration and stakeholder engagement in STEM education

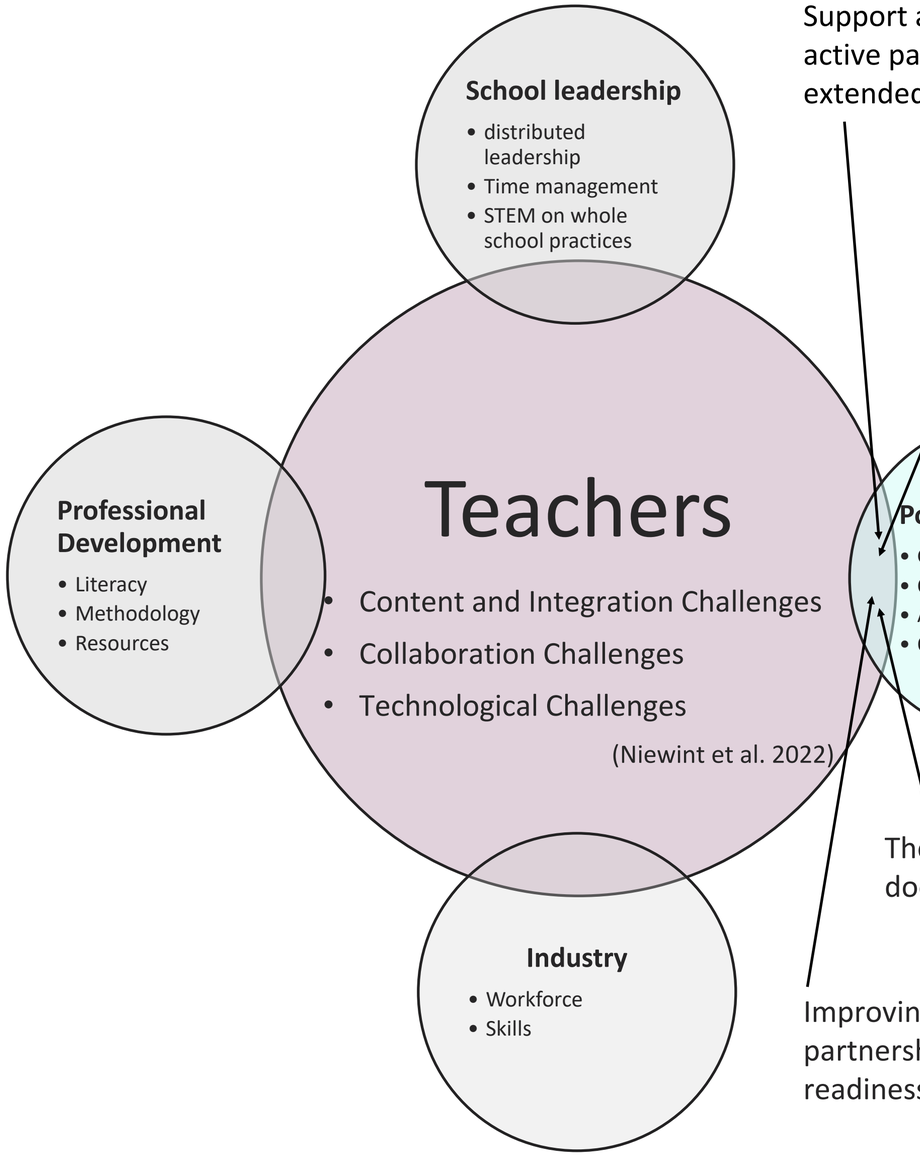
(Leung, 2020)

Raise career awareness and readiness in STEM careers through exploration, student internships, and teacher externships

(Ainslie & Huffman, 2019; Waite & McDonald, 2019)

Improving student engagement through education business partnerships, and government policy to enhance career readiness

(Ainslie & Huffman, 2019)



Support and promote a professional development with collective and active participation, consistent with the guidelines and curriculum of an extended duration

(Johnson & Sondergeld, 2016)

School curriculum needs to be ready to promote an integrated STEM approach

(Daniëls et al., 2019)

The formative-oriented integrated STEM approach which does not always fit easily into the curriculum

(Ryu et al., 2019)

Improving student engagement through education business partnerships, and government policy to enhance career readiness

(Ainslie & Huffman, 2019)

ISTITUTO NAZIONALE DOCUMENTAZIONE INNOVAZIONE RICERCA EDUCATIVA

Future Development

The SEER - The STE(A)M Education European Roadmap

Identify gaps in the european STEM education

Develop a set of roadmaps that will help improve STE(A)M Education from different stakeholders starting points

Provide a standard impact assessment mechanism for new STEM plans, projects, and initiatives

The SEER
STE(A)M EDUCATION EUROPEAN ROADMAP

Funded by the European Union

The work presented in this document has received funding from the European Union's Horizon Europe programme project the SEER (Grant agreement: 101058569), coordinated by European Schoolnet (EUN). The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

j.niewint@indire.it

References

Ainslie, P. J., & Huffman, S. L. (2019). Human resource development and expanding STEM career learning opportunities: Exploration, internships, and externships. Advances in Developing Human Resources, 21(1), 35-48.

Balgopal, M. (2020). STEM teacher agency: A case study of initiating and implementing curricular reform. Science Education, 104, 762-785.

Brown, R. E., & Bogiages, C. A. (2019). Professional development through STEM integration: How early career math and science teachers respond to experiencing integrated STEM tasks. International Journal of Science and Mathematics Education, 17, 111-128. https://doi.org/10.1007/s10763-017-9863-x.

Daniëls, E., Hondeghem A., & Dochy, F. (2019). A review on leadership and leadership development in educational settings. Educational Research Review, 27, 110–125.

Dare, E. A., Keratithamkul, K., Hiwatig, B. M., & Li, F. (2021). Beyond content: The role of STEM disciplines, real-world problems, 21st century skills, and STEM careers within science teachers' conceptions of integrated STEM education. Education Sciences, 11, 737.

Dong, Y., Wang, J., Yang, Y., & Kurup, P. M. (2020). Understanding intrinsic challenges to STEM instructional practices for Chinese teachers based on their beliefs and knowledge base. International Journal of STEM Education, 7, 47

Gale, J., Alemdar, M., Lingle, J., & Newton, S. (2020). Exploring critical components of an integrated STEM curriculum: An application of the innovation implementation framework. International Journal of STEM Education, 7, 5. https://doi.org/10.1186/s40594-020-0204-1.

Johnson, C. & Sondergeld, T. (2015). Effective stem professional development. STEM Road Map: A Framework for Integrated STEM Education. 203-211.

Kim, B. & Kim, J. (2016). Development and Validation of Evaluation Indicators for Teaching Competency in STEAM Education in Korea. EURASIA Journal of Mathematics, Science & Technology Education. 12. 1909-1924. 10.12973/eurasia.2016.1537a.

Leung, A. (2020). Boundary crossing pedagogy in STEM education. International Journal of STEM Education, 7, 15.

Niewint Gori et al. (2022). The European Integrated STEM Framework: Guidelines to Overcome barriers to STEM Integration, October 2022, European Schoolnet, Brussels

Ryu, M., Mentzer, N., & Knobloch, N. (2019). Preservice teachers' experiences of STEM integration: Challenges and implications for integrated STEM teacher preparation. International Journal of Technology and Design Education, 29, 493–512.

Tasiopoulou et al. (2020). STE(A)M IT Integrated STEM teaching State of Play, June 2020, European Schoolnet, Brussels

Waite, A. M., & McDonald, K. S. (2019). Exploring Challenges and Solutions Facing STEM Careers in the 21st Century: A Human Resource Development Perspective. Advances in Developing Human Resources, 21(1), 3–15. https://doi.org/10.1177/1523422318814482

Wang, H. H., Charoenmuang, M., Knobloch, N. A., & Tormoehlen, R. L. (2020). Defining interdisciplinary collaboration based on high school teachers' beliefs and practices of STEM integration using a complex designed system. International Journal of STEM Education, 7, 3.

Yoder, S., Bodary, S., & Johnson, C. C. (2015). Effective program characteristics, start-up, and advocacy for STEM. In STEM Road Map (pp. 211-237). Routledge.